

macroeconomía del desarrollo

Foundations of macroeconomic policy coordination: fostering dialogue as a policy tool in Latin America

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Abstract

This paper examines the theoretical foundations for macroeconomic policy coordination and the related empirical findings in Latin America, contributing an original analysis that advocates new dialogue mechanisms to facilitate coordination in this region. The theoretical survey is concerned with non-cooperative coordination games, including dynamic games and those with imperfect information. The practical value of these game-theoretic tools is illustrated using economic examples. One important result is that implementing different forms of dialogue in specific situations can help to reach a coordinated outcome with benefits across the board. This is argued to be especially relevant for macroeconomic policy coordination in Latin America because recent initiatives to advance the process of regional economic integration have strengthened the links between countries, creating new challenges for policy coordination.

I. Overview

In the 1990's, regional integration in Latin America received new impetus with the creation of new regional integration initiatives (MERCOSUR) and the re-launch of earlier ones such as the Andean Community. This revival of interest in regional integration came in parallel to the introduction of market reforms and liberalization processes in Latin America.

While regional integration initiatives were strengthened and national stabilization efforts were undertaken, an increase in the participation of intra-regional trade in total trade was observed in several countries. During this period, however, repeated episodes of large real effective exchange rate volatility were registered among the countries in the region¹, often in parallel with wide swings in real bilateral exchange rates between trading partners within a certain sub-regional group. The combination of high exchange rate volatility in a context of increased commercial links between countries in Latin America has been perceived in policy-making and some academic circles as increasing the possibility that macroeconomic instability is transmitted through spillover mechanisms from one country in the region to another. These developments substantiated the long-standing interest in regional coordination of macroeconomic policies², an

¹ See ECLAC (several years), Economic Outlook of Latin America and the Caribbean (United Nations ECLAC: Santiago de Chile), available from www.eclac.org.

² The Treaty of Asunción, signed on March 26th, 1991 which gave birth to MERCOSUR, specifies in its first article the willingness of the signing countries of engaging in the coordination of their macroeconomic policies: "*Artículo 1. Los Estados Partes deciden constituir un Mercado Común, que deber estar conformado al 31 de diciembre de 1994, el que se denominará "Mercado Común del Sur" (MERCOSUR). Este Mercado Común implica: [...]. La coordinación de políticas macroeconómicas y sectoriales entre los Estados Partes: de comercio exterior, agrícola, industrial, fiscal, monetaria, cambiaria y de capitales, de servicios, aduanera, de transportes y comunicaciones y otras que se acuerden, a fin de asegurar condiciones adecuadas de competencia entre los Estados Partes*", MERCOSUR's website, at <http://www.mercosur.org.uy/espanol/snor/normativa/asuncion.htm>.

interest with a long history in the economic and political economy literature (Currie et al., 1989).

A large part of the literature that models macroeconomic policy coordination (MPC, from now on) can be roughly divided into two groups. The first group focuses on the empirics of MPC, looking at the degree of spillovers among countries, at whether shocks affecting groups of countries that are potential candidates for coordination have symmetric effects, at the sources of those shocks (internal or external), etc. (eg. Fanelli and González-Rozada (2004)). The second group of papers seek to adapt macroeconomic models to incorporate spillovers, allowing the welfare effects of policy changes in one country to affect welfare in other countries, thereby assessing the desirability and potential effects of MPC. Within this group, the macroeconomic models that analyse MPC have evolved from Keynesian models (Canzoneri and Henderson, 1991) to New Open Economy Macroeconomic models³, as shown for example by the work of Canzoneri, Cumby and Diba (2002). The new open economy macroeconomic models allow welfare analysis of MPC (unlike older Keynesian models) because they explicitly introduce micro-foundations into their models.

In the empirical literature, considerations about the actual workings of the interaction between countries are often mentioned only in general terms or are even absent. In the theoretical literature, interactions are often modelled using simple game theoretic tools, assuming that countries maximise their welfare functions⁴ in a one-shot game of perfect information, where the outcome is a Nash Equilibrium. There are some papers, however, where consideration has been given to the problems presented by uncertainty about the models of the economy (Frankel and Rockett, 1988; Ghosh and Masson, 1991), and about many other issues and circumstances that can affect the implementation and welfare impact of MPC⁵.

In this paper, we will pursue two objectives. First, we will briefly discuss the different game theoretic tools useful to analyse the interaction among policy-makers that can potentially lead to MPC. In particular, we will explain how incorporating uncertainty, asymmetric information and looking at interaction in a dynamic framework can be analysed using game theoretic concepts and tools. Second, we will present arguments supporting the view that dialogue among policy-makers is a very potent instrument that might address several of the problems faced by policy-makers when trying to coordinate on an outcome that satisfies certain plausibility requirements (Nash Equilibrium) and which is preferred by at least one of the policy-makers and does not make others worse off (Pareto-superior).. In particular, we will propose that engaging in a dialogue process among policy-makers in Latin America can help to solve an array of multiple equilibria problems normally encountered in MPC, thereby becoming an important pillar in the process towards deepening regional integration in Latin America. The conceptual framework we will outline helps to understand the roles that dialogue and the exchange of experiences can have in the effort to achieve a Pareto-superior outcome for the group of countries involved. This conceptual background provides the basis for dialogue mechanisms currently in place like the Macroeconomic Dialogue Network (REDIMA) Project executed by ECLAC, and complements previous efforts to understand the rationale of macroeconomic dialogue in Latin America⁶ (Ghymers, 2005).

³ Surveys of New Open Economy Macroeconomic literature can be found in P. Lane (2001), *The New Open Economy Macroeconomics: A Survey*, *Journal of International Economics*, Vol. 54 (2), pp. 235 – 266, and in L. Sarno and M. Taylor (2002), *The Economics of Exchange Rates*, (Cambridge: Cambridge University Press, 2002).

⁴ These welfare functions are either ad hoc, in Keynesian-type first-generation models or endogenously derived in New Open Economy Macroeconomics second-generation models

⁵ These issues and circumstances include analysing the impact of asymmetric information on MPC; the challenges and opportunities presented by the dynamic nature of interaction potentially leading to MPC, and also the problems presented by dynamic inconsistency when MPC is attempted while the government interacts with the private sector in a Barro-Gordon type of way (eg. Rogoff, 1985).

⁶ Ghymers (2005) describes the experience of the first phase of the REDIMA (Macroeconomic Dialogue Network) Project, which took place between 2000-2003. The Project created an informal dialogue network among senior officials of Ministries of Finance and Central Banks of Latin America, divided into three sub-groups (Andean Community, MERCOSUR plus Chile and Central America plus the Dominican Republic). A second phase of the REDIMA Project, executed by ECLAC, United Nations with the technical and financial support of the European Union, started in early 2005.

The paper is organised as follows. Section II briefly discusses why policy coordination in Latin America might be desirable. Section III shows some of the methods through which policy interaction can be modelled using game-theoretic tools. Section IV explains the advantages, challenges and limitations of macroeconomic dialogue as a tool that can help countries to achieve a Pareto-superior result in their policy interaction. Section V concludes.

II. Issues in macroeconomic policy interaction in Latin America: why coordinate?

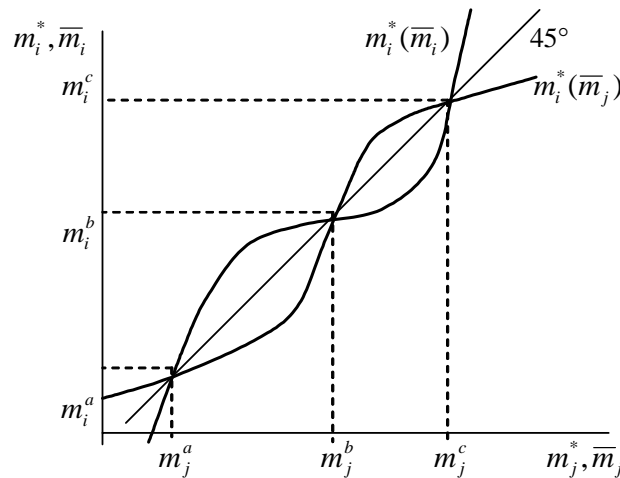
1. The theory

The main idea behind macroeconomic policy coordination (MPC) is that countries can be better off if they all take into account the welfare effects of their policy actions on their partners, as well as the others' policy responses to those actions. Normally, when countries decide on a certain macroeconomic policy action, they generally do not take into account the impact of those policies on the welfare of other countries: there are **spillovers** of domestic policies across borders. The most accepted channel of propagation of shocks is through trade, but there might be other channels⁷. It is also possible for a change in one player's strategy to alter the gains or losses of the other of changing his *own* strategy. If an increase in a player's strategy increases the optimal strategy of the other player, we are in the presence of **strategic complementarities** (i.e. the best response of each player is increasing in the action of the other players).

⁷ For example, basing its conclusions on several studies on the subject, Machinea (2003) suggests that capital inflows into emerging markets can be positively correlated, so that there might be contagion from one to another: "[...] distintos trabajos empíricos muestran la importancia del efecto contagio entre los países emergentes – el que sera más importante cuanto mayor sea la cercanía geográfica y el volumen de comercio -. [...] La existencia de contagio aumenta la posibilidad de perturbaciones communes, aún en situaciones en las que la salida de capitales o una modificación cambiaria en un determinado país sean consecuencias de factores domésticos", pp 24.

Cooper and John (1988)⁸ discuss the concepts of spillovers, strategic complementarity and multiplier effects in macroeconomics. The authors propose that strategic complementarity is a necessary condition for the existence of multiple Nash equilibria. Additionally, the authors show that if there are positive spillovers, that is, if an increase in the action of each agent results in an increase in the payoffs of the remaining agents, the existing multiple equilibria can be Pareto-ranked according to the size (level) of the action taken.⁹

Figure 1
STRATEGIC COMPLEMENTARITIES IN TWO COUNTRIES



Source: author's elaboration.

In figure 1 above, we present an adaptation of Cooper's (1999) diagram of an economy where strategic complementarities lead to multiple-equilibria. The two curves represent the monetary policy reaction functions¹⁰ $m_i^*(\bar{m}_j)$ and $m_j^*(\bar{m}_i)$ of countries i and j respectively, that is, the optimal responses of country i or j to the adoption of a monetary stance $\bar{m}_{i,j}$ by the other country. A tightening in one country's monetary policy stance results in the other country also having incentives to tighten its own monetary policy¹¹. Strategic complementarity is represented by the positive-slope of the reaction curves, which in this case leads to multiple equilibria. From Figure 1, we can readily grasp that there are three possible equilibria: a , b and c . While b is unstable (any infinitesimal deviation would lead to further deviations along both reaction curves, until one of the other (stable) equilibria were reached), both a and c are stable equilibria. In this simplified example, if we assume that low and high monetary stances respectively are associated with low and high inflation, we can think that both countries can either find themselves in an equilibrium with a low monetary stance (point a) and low inflation or in one with a high monetary stance (point c) and high inflation. As we will see later, this situation represents one of the (static) coordination games

⁸ The games discussed by Cooper and John (1988) fall into the larger category of supermodular games. See Cooper (1999), Chapter 2 and Fudenberg and Tirole (1991).

⁹ The authors also show that in order for a game to have multiple equilibria, not only must the game present strategic complementarities, but the reaction function of each player also has to have a slope higher than unity for at least one value of the action (see Appendix).

¹⁰ These reaction functions result from each country maximising a welfare function of the type $W_i = W(m_i, \bar{m}_j)$, where m_i is its own monetary policy stance and \bar{m}_j is country j 's monetary policy stance, taken as given.

¹¹ See Appendix II for a functional form of the reaction function that can produce these results.

(namely *Stag Hunt*) that we can encounter when two economies are closely linked and their policies are strategic complements.

Several authors show how spillovers might lead to countries seeking a cooperative outcome that is Pareto-Superior to a non-cooperative Nash Equilibrium solution. For example, Frankel and Rockett (1988) present a model where two countries choose their monetary policy in a first stage, in order to minimise a loss function of output and current account balance deviation from their optimal values; in a second stage, they add fiscal policy as a choice variable and inflation (in deviation form) as an additional welfare target. In their book, Canzoneri and Henderson (1991) use a Keynesian two-country model where nominal wages are contractually fixed, and where the authorities of both countries try to maximise a welfare function whose only attributes are employment (its deviation from full employment) and inflation. The only externality present in the latter authors' model is a spillover from the terms of trade to inflation. In such a setting, when a government uses monetary policy to counter the negative effects of a symmetric world productivity disturbance¹², the resulting monetary contraction in one country (taking the monetary supply of the other country as given) working via exchange rate appreciation increases the prices of imports in the other country (i.e. deteriorates the foreign country's terms of trade)¹³, increasing inflation in that country. If the shock affects both countries in a similar way, monetary contraction leads to excessive output contraction when countries do not coordinate their policy responses. This is because the bilateral real exchange rate between both countries does not appreciate, and therefore the monetary contraction necessary to restrain domestic inflation is larger. This lack of coordination results in lower welfare for both countries. Canzoneri and Henderson (1991) also show that when facing an asymmetric shock in demand that lowers demand for one country's product and raises demand for the other country's product, the monetary policy response of each country has a positive externality on the other one. This results in one country having to increase monetary supply less in order to boost demand, and the other one having to reduce it less, than it would be the case without externalities.

A second reason¹⁴ why countries might want to coordinate their macroeconomic policies stems from political economy issues (Eichengreen, 1998; Machinea, 2003; Fanelli, 2001). In countries where sectorial lobbies and pressure groups have a non-negligible impact on policymaking, an adverse modification in the relative prices faced by politically influential sectors might result in increased pressure on the authorities to obtain "protection" in the forms of tariffs, quotas, etc. Since it is difficult to model the transmission channel from a shift in relative prices to a policy change that counters it, a large part of the theoretical literature has avoided incorporating these dynamics into coordination models, despite several examples of trade policy changes in Latin America that seem to confirm its existence and analytic relevance. In any case, political economy issues add additional weight to the potential welfare gains from MPC in Latin America, via a reduction in the likelihood that countries use trade policy instruments to neutralise adverse relative price movements.

A third theoretical justification for MPC comes not from the size of the spillovers themselves but from the volatility that lack of coordination can induce in the partner country. According to this argument, MPC would be desirable to the extent that it could reduce volatility in variables such as the bilateral real exchange rate between two partner countries. According to Côté (1994), exchange rate volatility can affect not only trade, but also the structure of output and investment in a

¹² According to Currie et al., (1989), "Theory would suggest that the gains from coordination are greatest at a time of a large common shock, when countries acting in isolation might indulge in beggar-thy-neighbour attempts to manipulate exchange rates", pp 15.

¹³ If the appreciating country has market power in the export market of at least some products, and if those products are denominated in the exporting country's currency.

¹⁴ The political economy responses could be modelled by having multi-dimensional reaction functions that include both monetary policy and trade policy.

country¹⁵. Essentially, the theory of how exchange rate volatility affects trade is based around the idea that higher exchange risk can increase the risk uncertainty of exports' profits, so that risk-averse exporters will reduce exports when facing additional volatility. The importance of volatility depends on the degree of exposure to risk, which, in turn, depends on the currency used for contracting and any hedging opportunities, among other factors. However, and despite the construction of several theoretically plausible models pointing at the existence of a negative relationship between exchange rate volatility and trade, the empirical evidence has not been able to find conclusive evidence of such a relationship¹⁶. This is partly due to the several ways of measuring exchange rate volatility, and the fact that each of them presents methodological challenges. Therefore, assessing the direction of the relationship between exchange rate volatility on trade, and determining whether that relationship is significant is not a trivial task.

The theoretical literature, however, is not unanimously in favour of MPC. For example, Rogoff (1985) argues that cooperation among countries in setting monetary policy may be counterproductive if it reduces the credibility of central banks in their dealing with the private sector. When the private sector has to decide *ex ante* which wages to set, knowing that the Central Bank will then set monetary policy, the possibility of facing a depreciating exchange rate in an open economy acts as a restraint on the level of inflation that will be observed in a time-consistent equilibrium. Therefore, MPC in monetary policy between governments, by removing such constraint, can result in higher inflation and lower welfare. Frankel and Rockett (1988) suggest that a cooperative solution might not always be optimal if there is model uncertainty, in the presence of different beliefs about what the "true model" of the economy really is. Model uncertainty, according to Heymann (2001), is particularly relevant in countries that are going through transition processes (e.g. in their economic structure), because in those economies past patterns of behaviour do not constitute a good basis to formulate predictions about probable future behaviour. This is important because it could lead to authorities in different countries forming different, incompatible beliefs that can result in a coordination failure. Ghosh and Masson (1991), however, show that cooperation results in higher welfare if players update their beliefs about an unknown model using Bayesian updating in a Mundell-Fleming model with sticky-prices and rational expectations for exchange rates.

2. The empirical literature: what are the stylized facts for Latin America?

According to the review by McKibbin (1997), the empirical literature surrounding first-generation Keynesian models provided evidence of limited welfare gains from coordination after the size of the shocks that could lead to MPC is taken into account. In particular, the literature surveyed by McKibbin indicates that the size of gains for developed countries can be small if the comparison is between the optimal cooperative outcome and the "optimal" non-cooperative outcome.

In Latin America, MERCOSUR has attracted the greatest level of interest from the literature addressing MPC and integration. In this region, macroeconomic instability seems to have been one of the top difficulties hindering MPC, either directly (via its disruptive effects on trade (Heymann, 2004) and investment within a bloc) or indirectly (via increasing demands for protection from domestic firms). Many of the studies looking at MPC, especially those focused on MERCOSUR,

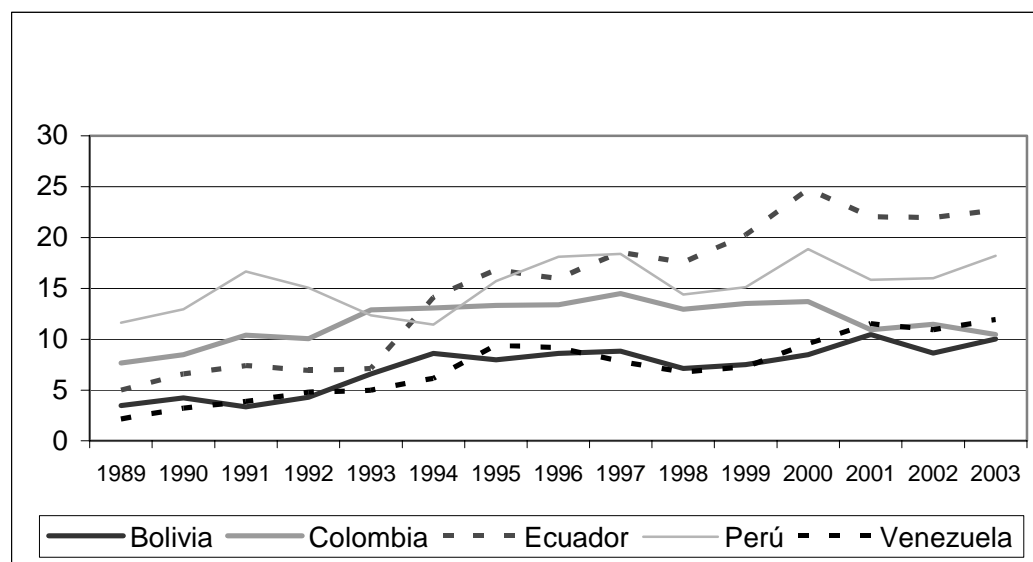
¹⁵ Good surveys of the theory and the empirical evidence of the relationship between exchange rate volatility and trade can be found in Côté (1994) and McKenzie (1999).

¹⁶ Many studies, especially early ones, did not find a significant negative relationship between exchange rate volatility and trade, while some studies have even found a positive one. The latest studies, using sectorial data and newer methodologies do seem to indicate that there is a negative relationship between both variables (Eichengreen (1998), McKenzie (1999)).

have used the Optimum Currency Areas criteria¹⁷ to discuss the advantages and disadvantages of coordination, including the desirability of (eventually) advancing towards a common currency (Carrera and Sturzenegger, 2000; Pineda and Pineda, 2003). These studies normally look at the degree of correlation of business cycles across countries, whether shocks affecting these countries are symmetric or not, the strength of trade linkages between countries, the amount of production factor mobility, etc. Eichengreen (1998) looked at whether it would be convenient for the MERCOSUR sub-region to have a unified currency, concluding that it would only make sense if it is part of a much deeper integration effort to which all countries can commit credibly. Fanelli and González-Rozada (2004) looked at whether the GDP of MERCOSUR countries vary symmetrically and the sources of shocks impinging on these countries. In particular, these authors found that spillovers between neighbours in MERCOSUR are significant.

In Latin America, recent time series data shows (see Graphs 1 to 6) that total trade within the different sub-regional groupings grew for many countries. Following the idea in the literature that commerce is the most important channel of transmission for shocks among countries, this data would indicate that spillovers among Latin American economies have increased since the 90's.

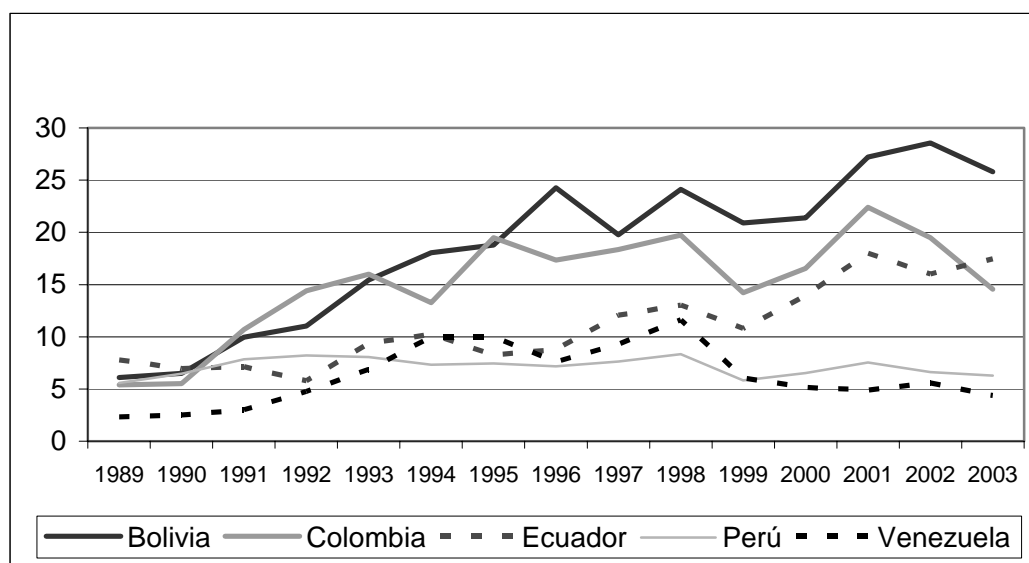
Figure 2
IMPORTS FROM THE ANDEAN COMMUNITY
(% of total imports)



Source: author's elaboration based on ECLAC's data.

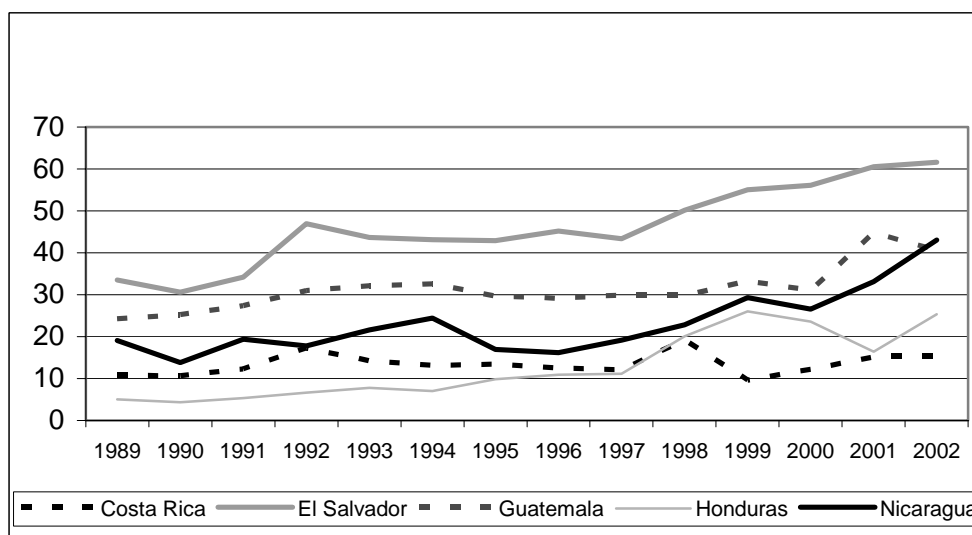
¹⁷ The classic reference about Optimum Currency Areas is Mundell, Robert A. (1961) "A Theory of Optimum Currency Areas", *American Economic Review*, Vol. 51, pp. 657 - 665. A more recent well-known study, which looks at whether the European Union before the euro could be considered an OCA is Eichengreen, B. (1991), *Is Europe an Optimum Currency Area?*, NBER Working Paper 3579, January 1991.

Figure 3
EXPORTS TO THE ANDEAN COMMUNITY
(% of total exports)



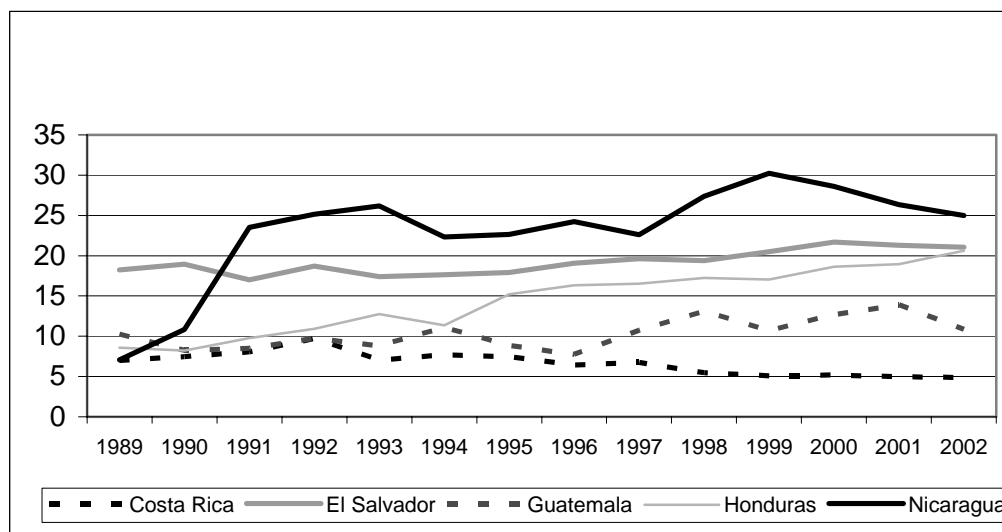
Source: author's elaboration based on ECLAC's data.

Figure 4
EXPORTS TO THE CACM
(% of total exports)



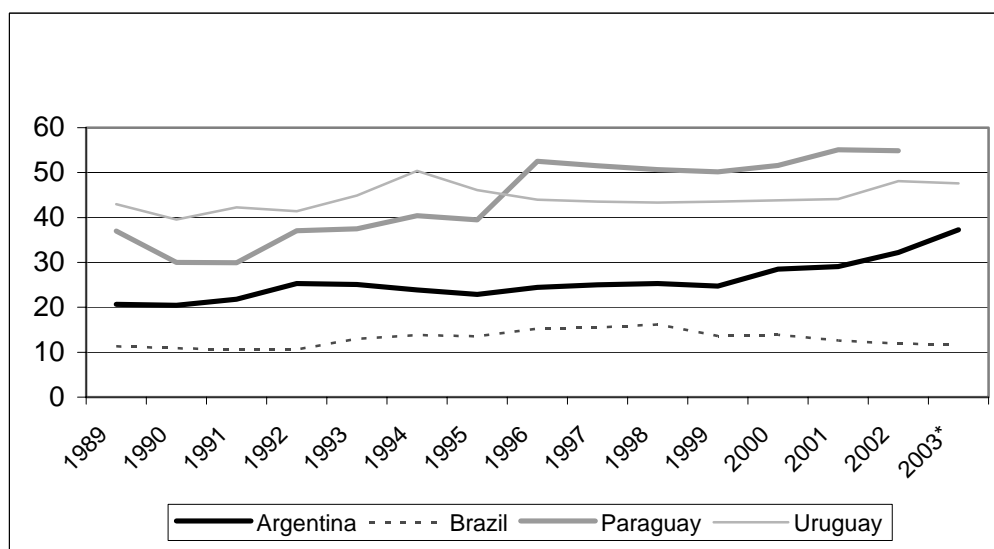
Source: author's elaboration based on ECLAC's data.

Figure 5
IMPORTS FROM THE CACM
 % of total imports



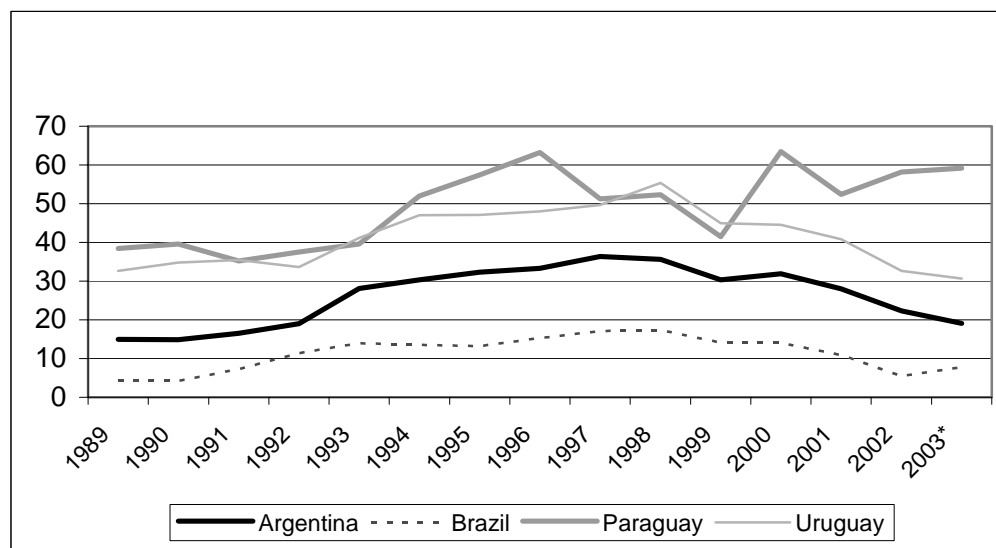
Source: author's elaboration based on ECLAC's data.

Figure 6
IMPORTS FROM MERCOSUR
 (% of total imports)



Source: author's elaboration based on ECLAC's data.

Figure 7
EXPORTS TO MERCOSUR
 (% of total exports)



Source: author's elaboration based on ECLAC's data.

In the graphs above, we can see that an important increase in the percentage of intra-regional exports, imports or both occurred between 1989 and 2003 within each of the three sub-regions: MERCOSUR, the Andean Community and for five Central American Common Market countries. We can see, however, that from the late 90's onwards trade has stagnated (or even declined) within MERCOSUR, while intra-regional trade growth also showed signs of slowing down in some of the countries belonging to other sub-regions.

Heymann (2004) indicates that the variations of bilateral trade between Argentina and Brazil have largely been related to the macroeconomic conditions of the importing country, especially the conditions of its business cycle but also the bilateral real exchange rate. The author also suggests (Heymann, 2001) that Brazil's Real plan of 1994 generated important positive spillovers on its MERCOSUR partners, notably in Argentina, whereas the floating of its currency in 1999 generated negative spillovers. Additionally, past changes in the bilateral real exchange rates between members of a sub-regional integration initiative have led to demands from negatively affected sectors for their governments to raise trade barriers against the depreciating trade partner¹⁸ (Eichengreen, 1998). Baer, Cavalcanti and Silva (2002) describe some protectionist measures taken by Argentina and Brazil during the 90s, and find (using a trade barrier equation) that increases in import penetration ratios in those countries result in increases in protectionist measures affecting trade between Argentina and Brazil¹⁹.

The increasing weight of regional trade in Latin America lends support to the idea that the trade transmission channels of a shock increase in association with the progress of sub-regional integration efforts over time. Bevilaqua, Catena and Talvi (2001) claim that for the smaller countries of MERCOSUR, the importance of the trade transmission channel of demand shocks among sub-regional partners does not depend on the **volume** of trade with those sub-regional partners, but on its **composition**. In particular, the authors claim that when a country's exports to a

¹⁸ Examples of this at different times during the 90's include Argentina, Brasil, and Colombia. See Eichengreen (1998) and Baer et al (2002).

¹⁹ The study, however, finds that concentration ratios are not significant in explaining increased protection and that union power is not significant. The authors acknowledge that the latter is probably due to data problems, but leave the former without explanation, which is rather surprising.

sub-regional partner country are dominated by commodities, a demand shock in the latter will have a minor welfare effect on the former, as products can be redirected towards other markets at little additional cost²⁰. However, if bilateral trade in “regional goods”²¹ is significant, a demand shock to one country might have significant negative effects on the welfare of trade partners, via a reduction in their exports of regional goods. Given that trade within MERCOSUR has an important component of regional goods and services, Bevilaqua et al. (2001) argue for the elimination of distorting policy measures that stimulate the production and consumption of artificially “regionalised” goods²² and for considering MPC as policies aimed at reducing vulnerability (defined as the required change of important macroeconomic variables following a shock) to partners’ demand shocks.

Other authors (Bevilaqua et al. (2001), Machinea (2003), Ghymers (2005)²³) have proposed that there can be contagion between countries via financial inflows. For example, Heymann (2004) has argued that changes in the volumes of capital inflows into MERCOSUR countries can be a source of spillovers when investors’ perception about the “risk” of one country impacts on the availability of credit to another (“contagion”)²⁴. One recent study with evidence of contagion effects is Fanelli and Gonzalez-Rozada (2004), which finds a negative association between the common cycle of MERCOSUR countries and their lagged combined country risk.

The greater significance of trade channels for the transmission of shocks has fostered an increased expectation that these channels will become even more important as sub-regional integration in Latin America intensifies in the future. This belief is anchored in integration initiatives such as the South American Community of Nations and free trade deals between the Andean Community and MERCOSUR, the willingness of other countries to make deals or become members of the existing sub-regional groupings, etc. With these developments has come a growing interest in MPC both in the academic literature and in policy forums. However, there have been few concrete examples of MPC in Latin America, in part due to macroeconomic instability in several countries, the low perceived levels of interconnection between countries, and different approaches to policymaking, among other reasons.

In the case of Latin America, three specific characteristics of the region can add to the challenge of implementing MPC.

In the first place, the region presents a wide variety of exchange rate agreements, as we can see in Table 1 below, despite moves in recent years towards more flexible exchange rate regimes in many countries.

²⁰ This assumes that the sub-regional partner is not a price setter in that good, so that a demand disruption in that country will not affect world prices for the commodity.

²¹ The authors define regional goods as “...goods that are tradable within the region but largely nontradable with the rest of the world”, Bevilaqua, Catena and Talvi (2001) pp. 156.

²² As an example, they mention trade in automobiles within MERCOSUR.

²³ “[...] globalization also increases externalities from national macroeconomic policy decisions through the impact of external financial flows. Hence, these growing interdependencies tend to reduce the effectiveness of national policies (thus diminishing each country’s possibilities for independent action); moreover, a country’s macroeconomic conditions depends increasingly on policies applied by neighbouring economies. The stronger the external dependencies on capital flows, the greater the reciprocal effects of the guidelines of the neighbouring countries’ macroeconomic policy mixes, in addition to the well known impact of reciprocal trade exchanges. Given psychological factors and the “herd” behaviour and massive nature of globalized financial markets, the perception of an economy’s financial sustainability has come to depend on the macrofinancial conditions of its immediate neighbours, substantially intensifying externalities from independent macroeconomic policies” Ghymers (2005, pp 97).

²⁴ “In the case of Argentina and Brazil, inspection of “country risk” indicators shows an association in their movements, but also wide shifts in the differential interest rate spreads of the two economies”, Heymann (2001), pp. 22.

Table 1
EXCHANGE RATE REGIMES IN LATIN AMERICA, 2004

	Exchange Rate Regime - 2004				
	Dollarization	Fixed Parity	Mobile Parity	Mobile Band	Flexible
Country	Panama	Venezuela	Bolivia	Honduras	Argentina
	Ecuador		Costa Rica		Brazil
	El Salvador		Nicaragua		Chile
					Colombia
					Guatemala
					México
					Paraguay
					Perú
					Dominican Republic
					Uruguay

Source: ECLAC (2004), Preliminary Overview of Latin America and the Caribbean

In the second place, coordinating fiscal policy might be particularly difficult in Latin America for a series of reasons. First, governments have few degrees of freedom in their capacity to execute fiscal policy, as budgets remain largely determined by extensive pre-allocations of revenue to specific uses and high personnel and transfer (e.g. pensions) expenditures, at the same time as debt levels remain high in several countries. Second, revenue in several countries (e.g. oil exporting ones) continues to rely heavily on royalties or taxes on commodity exports, which are vulnerable to international price reversals. If a country were to experiment a negative shock to the price of those exports, the need to change fiscal policy would probably exceed the one necessary if sources of revenue were more diversified. Both these empirical facts add to the complications of lags in designing and implementing fiscal policies in different jurisdictions, assessing the effects adjusting for these lags, etc. Moreover, to the extent that fiscal policy is severely restricted to be used in an anti-cyclical way, even in pursuit of purely domestic targets²⁵, it is difficult to think of supra-national coordination or cooperation objectives as being viable.

In the third place, monetary policy is sometimes also limited as a policy tool in some countries, in particular when the degree of financial deepening is low, the economy is highly dollarised, and the banking system is characterised by a high degree of market power (thereby hindering the lending channel of transmission of monetary policy).

²⁵ As pointed out by Fanelli (2001), fiscal policy is often aimed mainly at maintaining the solvency of the State.

III. A game-theoretic framework for studying macroeconomic policy coordination

In this section we turn from specific empirical aspects that appear crucial for MPC in Latin America to a discussion of generic game theoretic tools that can be used to analyse MPC in the context of policy interactions between countries.

According to Kreps, (1990b), game theory is a tool of economic analysis that helps to improve our understanding of specific economic situations. For this reason, applying game theory to the analysis of macroeconomic interactions emerges as a clear use for this tool. Classical game theory divided the field into the analysis of cooperative and non-cooperative games. According to Harsanyi and Selten (1988), the essential difference between cooperative and non-cooperative games is that the former allow binding (enforceable) agreements, while the latter do not. According to Rasmusen (2001), there is also a difference in the modelling approach used by each of them²⁶. In this paper, we will only discuss **non-cooperative games**.

A first reason not to deal with cooperative games here has to do with the different focus of this paper: our main interest is not in discussing the (complex) operational institutional arrangements (i.e. their form, evolution, reach, operation, etc) that can enforce a binding agreement between sovereign countries. When two countries decide to **cooperate**, they need to **commit** ex ante to play a certain set of

²⁶ As explained by Rasmusen (2001), “[...] cooperative game theory is a reduced-form theory which focuses on properties of the outcome rather than on the strategies that achieve the outcome” (page 21).

strategies to maximise their joint payoffs, thereby effectively **internalising** the (positive or negative) effects of **spillovers** of the actions of one country on another. When analysing cooperation among sovereign countries, the credibility of the commitment is particularly important, as government policy is often the result of complex coalition-building by different groups within a country, in a process that is dynamic by nature, and sometimes even volatile. Because of the impossibility to commit *ex ante* to every contingency, there is the need for supranational monitoring for an effective enforcing of agreements involving different sovereign nations²⁷. A second reason is related to the need to directly address the question of the allocation of the joint payoff among the different countries when discussing cooperative agreements. Therefore, describing the different issues behind the assorted bargaining processes that may take place between different countries goes beyond the goal of this paper.

In non-cooperative game theory, interactions between countries are represented by considering them to be “players” (defined as “rational decision makers” by Friedman (1990)) in a well-defined “game”. Macroeconomic policies are then the “actions” or “strategies” that lead to specified “payoffs” for each player²⁸. The equilibrium concept normally used in game theory is the Nash Equilibrium. A Nash Equilibrium can be defined as the set of actions for which no player has an incentive to deviate given the actions selected by all other players²⁹. A large part of the literature considers that Nash equilibria are reasonable predictions about how players will actually play.

Two-player non-cooperative one-shot games, that is, games between two players who select their equilibrium actions once only, are among the simplest games used to portray macroeconomic policy interactions between countries. As a simplification, the players are also often assumed to know their own payoffs and those of their competitors with any possible move they can take, and to know that others know that they know, and so on (known as “common knowledge”). When the number of players increases, when there are dynamic interactions between the players (i.e. the game extends over time, even forever) and when at least some of the players have incomplete information about some elements of the game (e.g. the exact form of the game tree, including the actions each player can take, their payoffs or the timing of the moves, as well as the information known to each player at each point in time), the complexity of games increases substantially. This same complexity has deterred a significant part of the policy-oriented literature from looking into the “black box” of policy coordination, focusing on the outcome instead. In turn, unfortunately, this has often resulted in reduced interest in coordination-enhancing mechanisms such as macroeconomic dialogue, as the interaction process that leads to coordination failure has often been insufficiently studied and understood by policymakers. The next subsections will present each of these alternative specifications and to discuss their implications.

1. One-shot games with perfect information

We can represent one-time policy interactions between two countries in game theoretic terms in different ways, depending on the exact specifications of the payoffs. To start, probably the simplest and best known (strategic form) representation of a one-shot game between two countries is the Prisoner’s Dilemma³⁰, shown on Figure 2 below³¹. The payoff structure of this game assumes $a > b > c > d$. On the right, we present a simple example.

²⁷ For example, with the game structure commonly known in the economic literature as a one-shot Prisoner’s Dilemma (see below), the joint maximum payoff is reachable if both countries can commit to playing the strategy *Expand Less*.

²⁸ This simplification implies assuming away the complexities and dynamics of decision-making *within* a government. However, the analysis of coalition-building and its impact on strategic interaction is beyond the reach of this paper. See Myerson (1991), chapter 9 for a technical examination of coalition building in game theory.

²⁹ A formal definition of a Nash Equilibrium, a concept that is central to non-cooperative game theory, is “a profile of strategies such that each player’s strategy is an optimal response to the other players’ strategies” (Fudenberg and Tirole 1991).

³⁰ The name “Prisoner’s Dilemma” comes from the well-known way of explaining this game as the interaction between two individuals accused of a crime that can either confess or not to having committed the crime.

Figure 8
THE PRISONER'S DILEMMA

		L	R			Expand More	Expand Less
U		c, c	a, d	Expand More		Low, Low	High, 0
D		d, a	b, b	Expand Less		0, High	Medium, Medium
		Prisoner's Dilemma				Prisoner's Dilemma Example	

Following Canzoneri and Henderson's (1991) model, assume that two countries face a symmetric positive productivity shock that increases output and puts a downward pressure on prices. If the authorities in each country are interested in keeping inflation and employment on target, the deflation set off by the productivity increase will provide an incentive to increase the money supply. Therefore, as a reply to the shock, both countries have to decide whether to expand their monetary supply significantly (the action *Expand More*) or just a bit (the action *Expand Less*). Expanding one country's money supply increases the consumer price indexes of both countries (they include domestic and imported goods), increasing domestic and foreign inflation³². If they both choose the action *Expand Less*, they go back to zero inflation and full employment (Medium payoff in the example of Figure 2), their joint bliss point. If both countries choose *Expand More*, they increase prices more than is optimal and both get a lower payoff (Low in the example). But the joint bliss point *Expand Less, Expand Less* will not be chosen by these players. The strategy *Expand Less* will not be played by either country, since it gives a lower payoff for every strategy that the other may choose³³. As a result, this one shot game has only one Nash equilibrium: the set of strategies (*Expand More, Expand More*) in which both countries end up worse off. A way out of the prisoner's dilemma in the one-shot game is if both players could **credibly commit** to playing the strategy *Expand less*, but commitments of this kind are not possible in this class of non-cooperative game. Ghymers (2005) discusses the issues that arise when countries perceive that they are playing a Prisoner's Dilemma-type of game with their regional partners.

The Prisoner's Dilemma is, however, only one out of many non-cooperative one-shot policy games that two countries can play. In particular, countries can also play a **coordination game**, where there are multiple Nash equilibria. Now we will review two well-known examples of coordination games: the "Battle of the Sexes" and the "Stag Hunt" game.

Following Cooper's (1999) treatment of coordination games, we present below in Figure 3 an example of the Stag Hunt game³⁴, with A, Y and $X > 0$.

³¹ This representation of a game, standard in the literature, has Player I (row) having possible actions U or D, and Player II (column) having possible actions L or R. The letter on the left of each strategy combination is the payoff to Player I and the letter on the right, the payoff to Player II.

³² A domestic monetary expansion produces two opposing effects on the demand for foreign products. First, demand for both domestic and foreign goods increases, increasing their prices. Second, as the exchange rate of the home country depreciates, the relative price of foreign goods increases with respects to home country goods (a deterioration of the terms of trade of the domestic country), reducing the demand for the former and increasing that of the latter. If we assume that the first effect is larger than the second, foreign prices increase. Additionally, for the monetary expansion to make sense to both countries' policymakers (i.e. for b and c to be positive), we need to assume that policymakers' loss functions weigh inflation deviations more heavily than employment deviations, as the monetary expansion increases both prices and employment, but the positive productivity shock had lowered prices without lowering output or employment.

³³ That is, the strategy *Expand Less* is strictly dominated (see Fudenberg and Tirole 1991, pp. 9 – 10. According to Myatt, Shin and Wallace (2002), "A dominated strategy is one that is worse than another strategy, no matter what actions are taken by the other players" (pp. 399, footnote 9).

³⁴ The name comes from the example of two hunters who have to decide whether to hunt a stag, for which both are necessary, or to hunt a rabbit, which provides less food per hunter but can be hunted by one person.

Figure 9
THE STAG HUNT GAME

	U	D		Don't Invest	Invest
U	0, 0	X, -Y	Don't Invest	0, 0	Low, Loss
D	-Y, X	A + X - Y, A + X - Y	Invest	Loss, Low	High, High
	Stag Hunt			Stag Hunt Example	

In this game there are two pure-strategy Nash Equilibria, in which players adopt symmetric actions (U, U) and (D, D). As in other coordination games, we assume that the players' welfare functions are such that these equilibria can be Pareto ranked, with the equilibrium (D, D) being preferred by both players. The aspect that is particularly important in this game is that neither of the actions is strictly dominated by the other, so there is no certainty about which of the two would be selected by rational players. There have been extensive experimental tests (see a survey in Camerer, 2003) about how individuals would play this type of game, and whether the Pareto-superior payoff will be reached more often than the Pareto-inferior one.

One can think of simple examples of this (symmetric) one-shot game, such as public investment in road infrastructure connecting two countries, on both sides of a border. Assume that each country can choose whether to *Invest* or *Don't Invest* in the project. If a country invests, it incurs a cost of Y , independently of what the other country does. If both invest, the project is achieved and each country reaps a benefit of A . Additionally, one country investing benefits the other by an amount X , independently of what this other country does. This means that investment generates a positive externality of size X that spills over across national borders. The two (symmetric) Nash Equilibria payoffs of this example are (High, High) for (*Invest, Invest*) and (0, 0) for (*Don't Invest, Don't Invest*).

A second well-known coordination game is the "Battle of the Sexes" (hereafter BOS), shown in Figure 4 below, where $a > b > c$.

Figure 10
THE BATTLE OF THE SEXES GAME

	F	B
F	a, b	c, c
B	c, c	b, a

Battle of the Sexes (BOS)

In this game, there are again two pure-strategy Nash Equilibria (F, B) and (B, F) and there is also a mixed-strategy³⁵ Nash Equilibrium where players "randomise"³⁶ between the two actions. Unlike the Stag Hunt game, these pure-strategy equilibria cannot be Pareto ranked, and the equilibrium payoffs are asymmetric since each country would prefer that the equilibrium reached were the one with the largest payoff for itself, even though it prefers the equilibrium with a low payoff rather than the coordination failure³⁷ as this results in the lowest possible payoffs (c, c).

³⁵ A mixed strategy is a probability distribution over pure strategies. See Fudenberg and Tirole (1991). A pure strategy can be seen as a mixed strategy where one of the actions is played with probability = 1.

³⁶ According to Harsanyi's Purification Theorem, any mixed-strategy Nash Equilibrium can be obtained as the limit of a pure-strategy Nash Equilibrium in a sequence of games that have payoffs that have been "perturbed" a bit. See Fudenberg and Tirole (1991), pp 233 for a technical explanation.

³⁷ In this paper, we follow Straub's (1995) definition of "coordination failure", which he defines (discussing 2x2 coordination games and Battle of the Sexes games) as "[...] the failure to obtain a Pareto optimal equilibrium" (pp. 340).

An informal example of a BOS macroeconomic game would have two countries choosing a more or less expansionary monetary stance, with a welfare function whose attributes were inflation and output. When facing a negative world demand shock, each of the two countries uses its monetary policy to minimise inflation and maximise output. In the example in Figure 5 below, the preferred Nash equilibrium for the Row player is to *Expand Less* while the Column player *Expands More*. Symmetrically, Column prefers that Row is the one playing *Expand More*. But both prefer the equilibrium where they are the ones expanding more to the cases where either both *Expand More* or both *Expand Less*.

Figure 11

PAYOFFS TO THE BATTLE OF THE SEXES GAME IN A MONETARY POLICY COORDINATION SITUATION

		Expand More		Expand Less	
		Expand More	Expand Less	Expand More	Expand Less
Expand More		Low, Low	High, Medium		
Expand Less		Medium, High	Low, Low		

Battle of the Sexes (BOS)

Player i's action	Player j's action	Inflation	Output	Player i's Total Payoff
Expand Less	Expand Less	Low	Low	Low
Expand Less	Expand More	Low	Medium	High
Expand More	Expand Less	Medium	High	Medium
Expand More	Expand More	High	High	Low

In one-shot coordination games such as these presented up to now, the all-important concepts of spillovers and strategic complementarities mentioned in section II.1 are clearly present. In the economic example of a Stag Hunt game shown above, there are positive cross-country spillovers from investing domestically and there are strategic complementarities, since each player has more incentives to invest when the other also invests³⁸. In the example of the BOS game above spillovers also appear. There, a monetary expansion in one country increases inflation, exports and output in the other, yet increasing the latter's payoffs.

The central question that must be posed for all coordination games is how to coordinate on one of the multiple equilibria, and which equilibrium will be chosen? That is the subject of section III.5. Before addressing that, though, we will introduce imperfect information and the possibility of dynamic play in the next two sections.

2. One-shot games with imperfect information

Very often, players of a game do not know with certainty all of the relevant information in a certain game³⁹, in which case the game is one of **incomplete** information (Harsanyi and Selten, 1988). A frequent assumption to solve games of incomplete information is to assume that individual payoffs are drawn from a distribution function which is common knowledge by all the players (Myatt, Shin and Wallace, 2002), and that these payoffs are “chosen” in a previous stage by one player called “Nature”, which represents random chance. That transforms the game of incomplete

³⁸ As explained by Fudenberg and Tirole (1991), the Stag Hunt game is *supermodular*.

³⁹ That is, as pointed out by Harsanyi and Selten (1988), players may not know the extensive form (the game tree specifying the moves in each period, the information sets, etc) or the normal/strategic form (the payoff matrix) of the game they are playing.

information into a game of **imperfect** information that can be analysed using standard game theoretic tools. Harsanyi and Selten propose that players face a game of complete but **imperfect** information⁴⁰ when the players know the nature of the game but don't know all the previous moves made by every player (including "Nature").

In the case of MPC in Latin America, randomness is introduced by changes in domestic conditions at every level (political, economic, etc), and in external conditions faced by each country, such as terms of trade, commodity prices, world interest rates, international liquidity, etc. Both are exogenous from the perspective of policymakers, but still have a profound influence on MPC. Additionally, over the years, succeeding governments of the same country have often shown to have different levels of interest in proceeding with sub-regional integration. We can represent the situation in which policymakers of partner countries do not know *ex ante* whether the government officials of other countries are keen on integration by using a game of imperfect information. We will start by looking at a one-shot game and incorporate the dynamic dimension in section III.5.

Imagine that the authorities of a certain country (Player II) member of a sub-regional grouping have just been voted into office. Assume that they can either be "*Interested*" in or "*Indifferent*" to integration, where the *Interested* type obtains a higher return from coordinating policies with the other country (Player I) while the *Indifferent* type of Player II obtains lower returns from coordination. For simplicity, assume that the payoffs of the incumbent authorities of the other country (Player I) are publicly known. For example, we could have the payoff matrices shown in Figure 6 below:

Figure 12

PAYOFFS IN A TWO-TYPE (ONE-SHOT GAME OF IMPERFECT INFORMATION)

	Coordinate	Independent		Coordinate	Independent
Coordinate	<i>High , High</i>	<i>0 , Med</i>	Coordinate	<i>High , Low</i>	<i>0 , Med</i>
Independent	<i>Med , Med</i>	<i>Low , Low</i>	Independent	<i>Med , 0</i>	<i>Low , Low</i>
Type A: Player II "Interested"			Type B: Player II "Indifferent"		

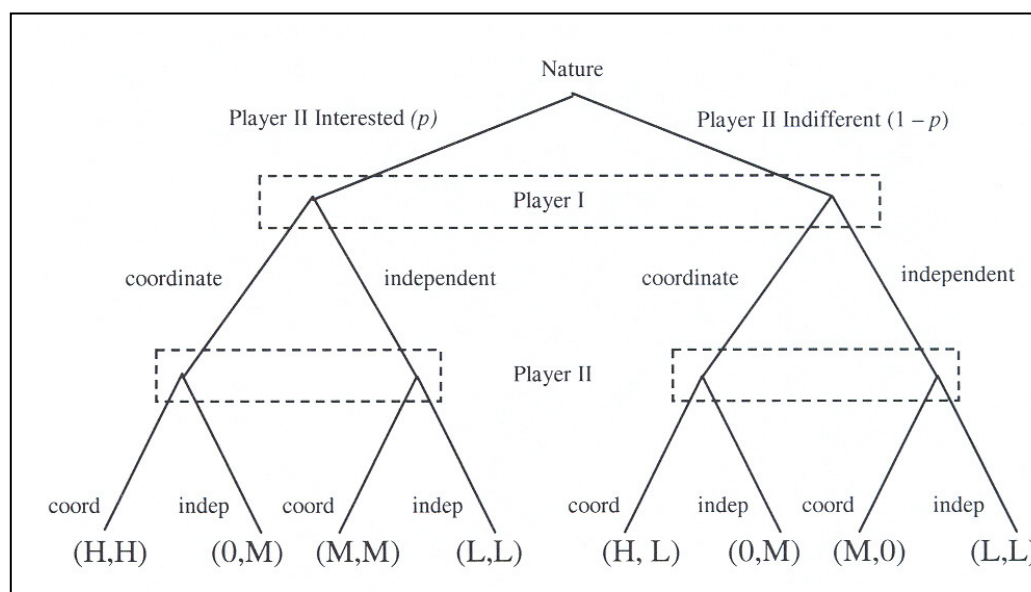
If Player II's type was known to be "Interested" by both players (i.e. if both knew with certainty that the left matrix represents the true payoffs), both players would be playing a Stag Hunt game with strategic complementarities. Each country has more incentives to coordinate if the other also coordinates and there are spillovers for both possible types of Player II, since each country benefits if the other coordinates, independently of its own actions.

Implicit in the payoff matrices above is the assumption that officials of both governments will want to coordinate with their counterparts if both are "Interested" in integration, but not otherwise. If the incumbent authorities (Player I) knew the type of the other player with certainty (i.e. if there were perfect information), the Nash equilibria of the two possible games that could be played are highlighted in the figure. Instead, suppose that the newly elected officials know their type but nobody else does, even though everybody has the same common *ex ante* beliefs about the probability p that the incoming officials (Player II) are "interested". We can represent such a game using the following extensive form, where H stands for High payoffs, M for Medium and L for Low payoffs:

⁴⁰ There is some controversy about whether a game where information is incomplete in the sense mentioned above is well defined at all. Rasmusen (2001) refers to "incomplete" games as those where, after a Harsanyi transformation, Nature moves first and his move is not observed by every player. Here we have used the "old" or "traditional" definition of "incomplete information". Kreps (1990a) indicates that, as mathematical models, games of incomplete information and imperfect information (when defined as above) are the same.

Figure 13

EXTENSIVE FORM REPRESENTATION OF A ONE-SHOT GAME OF IMPERFECT INFORMATION



Once “Nature” chooses the type of Player II (i.e., Player II finds out what type he really is), both authorities have to decide which strategy they will play, considering both the possible moves that each “type” of the other player is expected to take, and the probability of observing such a type. In the simple example above, Player II knows that if his type is “Interested”, playing the strategy Coordinate is dominant for him, while if his type is “Indifferent”, playing the strategy Independent is dominant instead. Player I knows this, so he will play Coordinate only if the prior belief that Player II is of the “Interested” type is high enough⁴¹. Therefore, if the gains from coordination are not very large (they equal 5 in our example), Player I needs to be very sure⁴² that Player II is of the Interested type for that group of authorities to “coordinate”. Otherwise, it is in their interest to maintain an independent policy. More will be said on strategic risks of playing different strategies in section III.5.I.

3. Repeated games with complete information

A one-shot game can be informative in understanding the decision processes in MPC, but as there are essentially dynamic aspects of the interaction between countries it is important to consider these explicitly when modelling coordination. As pointed out by Heymann (2004), coordination among countries is difficult to understand without thinking of repeated interaction between players. The dynamic nature of games of policy coordination supposes that different countries are interacting over a long horizon of uncertain duration, which can be modelled as an infinite horizon. We will introduce dynamic interaction among countries by introducing the concept of a **repeated game**.

As pointed out by Rasmusen (2001), in repeated games the fundamental rules framing the decisions do not change from one repetition to the next, only the history of play increases. When the same one-shot game is played either (i) an infinite number of times or (ii) a finite but initially

⁴¹ For example, assigning values like $H=50$, $M=45$ and $L=40$, the prior needs to be higher than $8/9$ in the example.

⁴² In our simple example above, only one of the authorities had imperfect information. In a more realistic situation, there is uncertainty about the types of every player, placing additional demands on the amount of “certainty” necessary for all the players to play the *Coordinate* strategy in equilibrium.

uncertain number of times (there is a non-zero probability of the game ending in any stage)⁴³, the equilibrium outcomes can be very different from the Nash equilibria observed in a single one-shot game. According to the Folk Theorem, which is a particularly important result in dynamic games, any feasible and individually rational⁴⁴ payoff can be a Nash equilibrium of an infinitely repeated stage game such as the Prisoner's Dilemma⁴⁵ for a sufficiently low discount rate (Fudenberg and Maskin, 1986). The result rests on the potential retaliation when an "uncooperative" strategy is used.

In an infinitely repeated Prisoner's Dilemma with the payoff structure described in Section III.I, the Pareto-efficient outcome (*Expand Less, Expand Less*) can be reached in a non-cooperative manner (i.e. with each country pursuing only its best interest). The generalised adoption of what are known as **trigger strategies**⁴⁶ such as the *Grim* strategy (a country chooses *Expand less* and continues doing so for as long as the others choose the same action in every stage game, but reverts to the action *Expand More* forever if another country chooses *Expand More* even just once) can lead to countries reaching a Pareto superior outcome. This occurs because (assuming perfect information) the future cost of deviating today is higher (given a low discount rate) than the current gain from deviating: the large payoffs foregone because of "punishment" during an infinite number of future periods can lead countries not to deviate today from the strategy that attains the Pareto-superior outcome.

Repeated games have been argued to be a possible way of facilitating play of a Pareto-efficient result (e.g. Canzoneri and Henderson 1991). Looked at from this optic, a repeated game of perfect information is essentially an illustrative tool when analysing MPC, which allows the analyst to model in a simple way how incorporating the dynamic dimension to allow outcomes that are not Nash equilibria of the static one-shot game.

Repeated games of perfect information face several limitations when used for analysing MPC in the real world. In the first place, as pointed out by Canzoneri and Henderson (1991) and Kreps (1990a) among many authors, infinitely repeated games have multiple equilibria (this is one of the implications of the Folk Theorem). As a result, we require a way of determining ex ante which of those equilibria is more likely to be played in the real world. For modelling to have any practical applications, infinitely repeated games require an "equilibrium selection" criterion. Even though some Nash Equilibrium refinements might reduce this problem, equilibrium selection is one of the central challenges faced by a game-theoretic approach to MPC, as we will discuss further in section III.5. In the second place, if the game is not repeated an infinite number of times, other assumptions are necessary to ensure that a Pareto-efficient result is reached in the repeated game. We have already mentioned uncertainty about game duration, which is often assumed, in order for the finitely repeated game not to unravel from the last period of the game (Fudenberg and Tirole 1991, Rasmusen 2001)⁴⁷. In the third place, it might not be a credible threat to use "trigger-strategies" such as *Grim*, which involve very costly punishments if one of the players deviates. Particularly in the case of the Prisoner's Dilemma, certain equilibria that involve playing strategies that "punish the punisher" might not be credible. After observing a deviation by one player, the other player(s) might prefer to treat deviation in the last period as a "bygone", and continue to play the static

⁴³ This is different from knowing that the game will end at some unspecified future date before the end period of the game.

⁴⁴ According to Fudenberg and Maskin (1986), "An outcome that Pareto dominates the minimax point is called individually rational" pp. 533.

⁴⁵ If, on the other hand, the perfect-information one-shot Prisoner's Dilemma game is not repeated an infinite number of times, the game unravels from the last period of play to the first one, and the only possible result is the play of the Pareto-dominated equilibrium in every repetition of the one-shot game.

⁴⁶ "A strategy that dictates following one course of action until a certain condition is met and then following a different strategy for the rest of the game is called a trigger strategy", Gintis (2000), pp 119.

⁴⁷ If the horizon is finite with certainty, then the only possible equilibria are the same as those of the one shot game, for the game unravels due to backward induction. We do not discuss finitely repeated games here, and the associated concept of "subgame perfection". For more on that, refer to Myerson (1991) or Rasmusen (2001).

Pareto-superior outcome of the stage game. For example, according to Fudenberg and Tirole (1991), neither the *Grim* strategy nor perfect *tit-for-tat* are (weakly) renegotiation proof⁴⁸.

Repeated games where players have symmetric information have been used to illustrate the idea of “trust” building among countries⁴⁹, but we should be careful not to overstate the contribution they can make to our understanding of the issues behind MPC. In particular, modelling MPC needs to take into account asymmetric information and uncertainty, as both elements are pervasive in real world policy decisions and negotiations. This motivates the study of games with imperfect information in the next section.

4. Dynamic games with imperfect information

When country officials meet, they never know the exact payoff function that officials in other countries are trying to maximise. This might be due to several reasons. For example, authorities might be new to the job, or political conditions might have changed the preferences of authorities. Additionally, they might not even be sure about what game they are playing. Therefore, an important part of the MPC process is for country officials to try to determine the payoffs and preferences of their counterparts, in order to ascertain the likelihood of observing different actions or strategies. In dynamic games of imperfect information, players use the information that becomes available to them by updating their beliefs after observing the actions taken by the other players at each stage. In these games, beliefs and strategies are closely linked and cannot be understood separately.

One situation where it is worthwhile including the dynamic dimension in the presence of uncertainty into the analysis is when there is frequent replacement of the authorities of member countries of sub-regional groupings, and there is no stability in the policies pursued by succeeding administrations. This phenomenon is not uncommon in Latin America and one of its facets concerns the numerous changes in economic authorities during the 90's (see Table 2 below).

⁴⁸ In the *tit-for-tat* strategy for two players of a repeated game, each player plays in the current period the strategy that the other player chose in the previous period, thereby “punishing” past deviation but only for as long as the other player keeps choosing “uncooperative” actions. The intuition of renegotiation-proofness is explained by Fudenberg and Tirole (1991): “*The idea is that if equilibrium arises as the result of negotiations between the players, and players have the opportunity to negotiate anew at the beginning of each period, then equilibria that enforce “good” outcomes by the threat that deviations will trigger a “punishment equilibrium” may be suspect, as a player might deviate and then propose abandoning the punishment equilibrium for another equilibrium in which all players are better off*” pp. 175.

⁴⁹ A key issue in dynamic games is that the history of play of each opponent encountered is common knowledge (i.e. every player knows how each opponent has played in the past), and that at least one of the players plays the game more than once. This is an important difference with respect to the repetition of a one-shot game, when the opponents are anonymous and their past play is unknown. In such a case, the threat to punish deviant behaviour in the future (repeated games) or building reputations lose their meaning.

Table 2

VOLATILITY OF ECONOMIC AUTHORITIES IN LATIN AMERICA (SELECTED COUNTRIES)

Country	Number of Central Bank Governors during the period					Average period (months)
	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004	
Mercosur						
Argentina	5	5	4	1	5	15.0
Brazil	2	6	5	4	1	16.7
Andean Community						
Bolivia	7	4	2	1	1	20.0
Venezuela **	2	3	3	0^	1	21.6
** there was no information about the period from january 1984 - november 1987 and there was no ending date given to the governor's period from 1994, only the next presidency from 2000 onwards. Therefore, the average period does not include neither the 46 months of the first period nor the 60 months between 1995 and 1999						

Country	Number of Finance Ministers during the period					Average period (months)
	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004	
Mercosur						
Argentina	5	6	1	2	8	13.6
Brazil *	1	7	9	1	1	15.8
Andean Community						
Ecuador	4	4	4	9	7	10.7
Perú	3	7	3	3	6	13.6
Venezuela	3	2	4	4	2	20.0
* numbers partly estimated, since there were no exact dates given						

Source: author's estimates based on the institution's webpages and other sources. Preliminary estimates subject to revision.

In a context of continual changes in the partner authorities, ascertaining the interests and limitations of the other players becomes much more important, at the same time as the possibility to interact repeatedly (without a clear time limit) allows play to be different from the one observed in one-shot games.

Modelling strategic interactions between players in a dynamic setting and in the presence of incomplete (imperfect) information can easily obscure the issues at hand when the added realism and relevance of the resulting models is traded against a significant increase in complexity. Our interest in this section is merely to sketch how macroeconomic policy interactions among countries can be modelled⁵⁰ with these contemporary game-theoretic methods.

The dynamic games of imperfect information we might be interested in analysing often have multiple Nash equilibria. In trying to determine *ex ante* which of these is more likely to be played, the modellers of dynamic games of imperfect information often rely on refinements⁵¹ of the Nash equilibrium. The idea is to eliminate a series of outcomes that are considered “unlikely” to be played, especially when they are based on “unreasonable” beliefs for actions that are not taken by players as part of an equilibrium (i.e., off-the-equilibrium-path beliefs).

We will start by looking at signalling games, in order to show the equilibrium concepts used when there is more than one period of play and information is not complete. Then, we will address repeated games with incomplete information, in order to look more closely at the issues of reputation building between policymakers.

⁵⁰ For a thorough treatment of these issues, see the several excellent game theory texts that deal with dynamic games with incomplete information, including Gibbons (1992), Fudenberg and Tirole (1991) and Rasmusen (2001), as well as the references therein. Of especial relevance is Fudenberg, D. and Tirole, J. (1991b).

⁵¹ These refinements include the Perfect Bayesian Nash Equilibrium, Sequential equilibrium, and others. See Fudenberg and Tirole (1991).

4.1 Signaling games

When some players know something that others do not (asymmetric information), the informed players might want to send a “signal” to the uninformed ones about the private information they have, if they benefit from doing so (Gintis, 2000).

As an example of a signalling game among policymakers, imagine that an incumbent group of authorities, whose preferences about integration and regional cooperation are publicly known, interacts with a group of incoming authorities, whose preferences (i.e., payoffs) from pursuing integration are not well known. If the payoffs of the incoming authorities are private information, assume that the incumbent authorities **first** observe the actions of the incoming authorities and **then** use that information to update their prior beliefs about what “type” of agent they are facing. The “type” of the incoming government’s authorities in this case are a series of characteristics that are unobservable by third parties, such as its political economy welfare function, the actual shock they face that is causing them to take action, etc, all of which potentially affect the decisions of the incoming authorities. This is a two-period game of imperfect information.

As pointed out by Fudenberg and Tirole (1991), the central features of a signalling game can be captured in a simple setting with two players. Player I is the leader (or sender of the signal) and Player II is the follower (or receiver of the signal). Player I’s type is chosen by Nature from a certain probability distribution that is common knowledge⁵². Only Player I learns his type, but this is unobservable to Player II. As Kreps (1990a) explains, every player knows (and knows that everybody else knows, etc) the possible “types” of player (i.e. policymaker preferences) that “Nature” (chance) can pick. To simplify, we assume that the type of Player II is common knowledge⁵³. The actions of each player are observable by both. Player II observes the action of Player I before choosing his own move, and updates his prior beliefs about Player I’s unobservable type using Bayes’ rule. Player II’s chosen action maximises his payoff conditional on the observed move by Player I and the beliefs held by Player II. Therefore, Player I will take into account the effect of his future move on the future action of Player II.

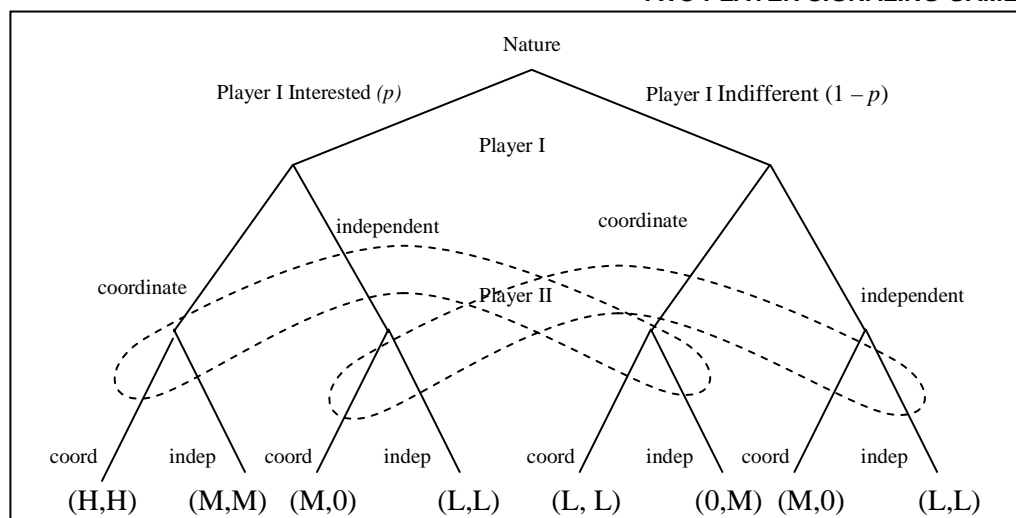
In this type of game, an equilibrium concept frequently used and that “refines” Nash equilibrium is the Perfect Bayesian Equilibrium (PBE). Concretely, a PBE has been defined as “...a set of strategies and beliefs such that, at any stage of the game, strategies are optimal given the beliefs and the beliefs are obtained from equilibrium strategies and observed actions using Bayes’ rule” (Fudenberg and Tirole 1991, p 326). We will now represent an example of a signalling game that fulfils these characteristics.

Imagine that the Ministries of Finance of two neighbouring countries are deciding the allocation of next year’s budget for transport and energy infrastructure. Each Ministry can play one of two possible actions: budget investment in infrastructure mainly geared for connection with the other country, an action that we will label *Coordinate*, or alternatively budget investment in infrastructure mainly to serve the needs of the interior of the country, an action that we will label *Independent*. One country decides its budget earlier in the year (Player I), so its choice will be observed by the other country (Player II) before the latter decides on its own budget. We also assume that the payoffs of the Ministry of the country moving in second place (Player II) are known by everybody, but Player I’s payoffs are private information to him.

⁵² Player II has a certain prior probability for each possible type of Player I, Player I knows that Player II has those priors, Player II knows that Player I knows, etc.

⁵³ See Kreps and Wilson (1982) for more on two-sided uncertainty in a dynamic game of incomplete information. In particular, the authors deal with a “chain store paradox”-type of game, where an incumbent tries to deter entry by a potential entrant.

Figure 14

TWO PLAYER SIGNALING GAME I


For simplicity, let us assume that Player I can be of one of two “types”. With prior probability p of 25%, Player I is “Interested” in coordinating with its neighbour: his political platform favours long-term integration with regional partners, the current state of inward-looking infrastructure does not require immediate investment, powerful export and import lobbies are putting pressure on the Government to invest heavily in connection infrastructure with its neighbours, etc. Alternatively, with prior probability $(1 - p)$ of 75%, Player I is “Indifferent” to coordinating with its neighbour: regional integration is low in its political priorities, its internal infrastructure is severely inadequate, politically powerful groups supplying the internal market are lobbying for public infrastructure investment in the country, etc. These two different “types” of Player I have ordinal payoffs as indicated in Figure 8, with H standing for High payoffs, M for Medium, and L for Low, all three larger than zero, with $H > M > L$. Importantly, it emerges that in this example it is a dominant strategy for the “Interested” type of Player I to play *Coordinate*.

A pooling Perfect Bayesian Equilibrium (PBE) of a signalling game is a PBE where all types of Player I choose the same action in period 1, so that Player II cannot update his beliefs about the type of player I. In the present example, there is no pooling PBE, neither if both types of Player I play *Coordinate*⁵⁴ nor if they play *Independent*. In a separating PBE, each type of Player I plays in a different way. In our example, there is a separating PBE where the “Indifferent” type of player I plays *Independent* and the “Interested” type of player I plays *Coordinate*. This shows that, even for a relatively low prior probability of observing an “Interested” type of Player I, such a type of Ministry may be able to effectively signal its willingness or capacity to coordinate its investment policy with its neighbour⁵⁵. This outcome is a PBE because the behaviour by both types of Player I is sequentially rational: given the set of beliefs, no player can gain by deviating from this strategy at one of the information sets (marked within dotted lines in Figure 8) that represent a decision under uncertainty; and beliefs on the equilibrium path are derived using Bayes’ rule.

Let us now look at a slightly modified game, where playing the action *Coordinate* is no longer a strictly dominant strategy for the “Interested” type of Player I. In the game in Figure 9, we have modified the payoffs so that the “Interested” type of Player I will be willing to play *Independent*, just like the “Indifferent” type, if the prior beliefs about Player I being an “Interested” type are low enough (as this causes Player II to play *Independent*). The shadowed payoffs are the only changes with respect to the game in Figure 8.

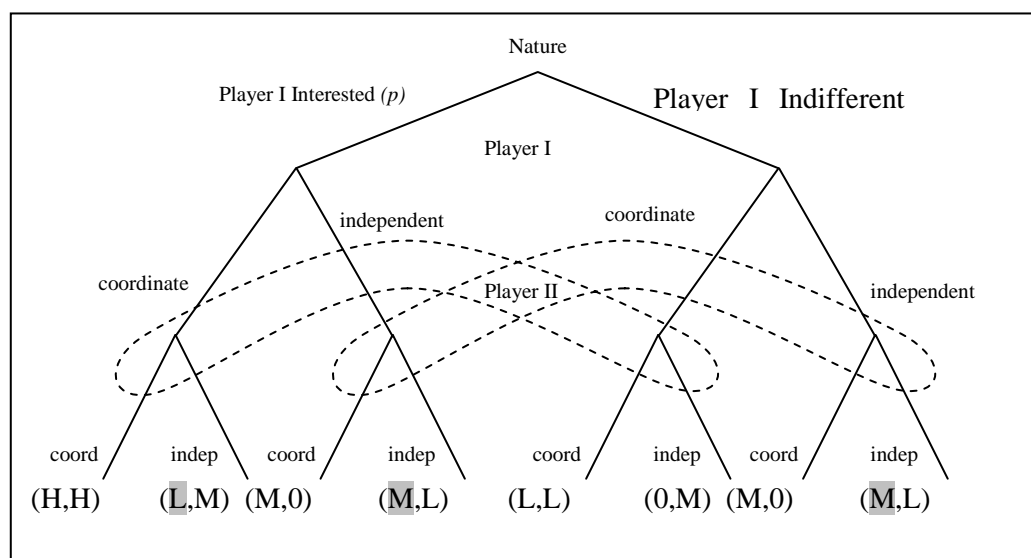
⁵⁴ It is assumed that off-the-equilibrium-path Player B answers with *Independent* if Player I deviates from *Coordinate* and plays *Independent* instead.

⁵⁵ See Appendix I, game 1 for a longer discussion of a numerical version of this game.

In this game, the separating PBE in which Player II answers to a *Coordinate* policy with *Independent* (due to the prior p) is not the only pure-strategy PBE. There is also a pooling PBE where both players choose *Independent* budgets that do not favour integration infrastructure, even though the “Interested” type would have preferred to *Coordinate* its investment in infrastructure budget with its neighbour, had he believed that Player II would respond with *Coordinate* to his playing *Coordinate*.

In particular, the simple example in Figure 9 shows that even if both players would want to play *Coordinate* in a perfect information game (i.e. they really belong to the “Interested” type), imperfect information about the player type and the sequential nature of dynamic play might result in both players choosing a Pareto-inefficient PBE where both play an *Independent* budget, because of the possibility that the player moving first is not interested in coordination (i.e. the exogenous prior probability that he is of the “Indifferent” type). This shows the importance of beliefs for MPC processes among policymakers in a dynamic and information-imperfect environment.

Figure 15
TWO PLAYER SIGNALING GAME II



Finally, it is straightforward to build another version of this game, where both types of Player I play *Coordinate* and a pooling equilibrium in that strategy is the only pure-strategy PBE.

4.2 Repeated games with imperfect information: reputation effects

After having looked at the two-period game in the previous section, we might ask what happens when players interact many (an infinite or uncertain number of) times, in the presence of uncertainty. This is what we will discuss here.

When we discussed one-shot games of imperfect information (section III.2), we assumed that players' beliefs about each other were given exogenously. However, as pointed out by Myerson (1991), in real life situations beliefs are often the result of protracted interaction among players. Policymakers who interact repeatedly with their counterparts from other countries as they implement macroeconomic policy might want to establish a **reputation**. This means they may want other policymakers to come to expect that they will take certain actions and not others when setting macroeconomic policy. According to Fudenberg and Tirole (1991), reputation can then be modelled by considering that there are different “types” of players, where each type is expected to play in a certain way. Reputation would therefore be anchored in the beliefs each player has about the

probability that other players are of a certain type. This interpretation of reputation is distinct from the one that often relates reputation building with repeated games of complete information⁵⁶.

The reputational aspects of interaction can be very important in practical MPC when players do not know *ex ante* whether they will profit from coordinating their policies with others or not. Imagine that two countries that are members of a sub-regional integration effort are trying to coordinate their policies for attracting Foreign Direct Investment (FDI). In particular, since attracting FDI is a protracted process that involves long time periods, the concept of reputation building might be particularly important. For example, assume that one of the countries (Player I) can either be “Interested” or “Indifferent” to coordinating its policies with a sub-regional partner. As in the example we presented in the previous section, the types are really a shorthand for a variety of characteristics of the welfare functions being maximised by each Government, as well as any restrictions they might face, both of which are private information.

Figure 16
NUMERICAL EXAMPLE OF STAGE PAYOFFS (REPUTATION GAME)

	Coordinate	Independent		Coordinate	Independent
Coordinate	3, 2	2, 1	Coordinate	2, 0	0, 1
Independent	2, 0	1, 1	Independent	2, 0	1, 1
Type A: Player I "Interested"			Type B: Player I "Indifferent"		

First, assume that Player I's type is observable by both players and assume each game is played only once, where the payoffs are ordinal⁵⁷ such as those in Figure 10. Then, the “Interested” type of Player I always *Coordinates*, for it is a strictly dominant strategy for him to do so, while the “Indifferent” type does not, for the action *Coordinate* is strictly dominated for him. Therefore, the unique pure-strategy Nash Equilibrium of each perfect-information one-shot game is (*Coordinate*, *Coordinate*) if Player I is “Interested” and (*Independent*, *Independent*) if Player I is “Indifferent”.

Let us now introduce imperfect information and dynamics. Imagine that one of the two countries (Player I) will put in place their legislation and other FDI-related policies first, so that Player II will be able to observe the other's policy choice before taking his own policy decision. Player I knows whether he is “Interested” or “Indifferent” and the payoffs of Player II, but Player II only observes Player I's action and has a probability distribution over Player I's possible types. We will assume that the prior probability (which is common knowledge) of Player I being “Interested” is $p = 0.6$. Therefore, the extensive form of that game of imperfect information is represented in Figure 11.

In the game in Figure 11, upon observing Player I play *Coordinate*, Player II plays *Coordinate* since the prior that Player I is of the type “Interested” is larger than 50%. We assume that if Player II sees Player I playing *Independent*, he will assume that Player I is of the *Indifferent* type (playing *Coordinate* is strictly dominant for the *Interested* type, so he will always play that action, no matter how he expects Player II to play) with probability one. Since this is so, an

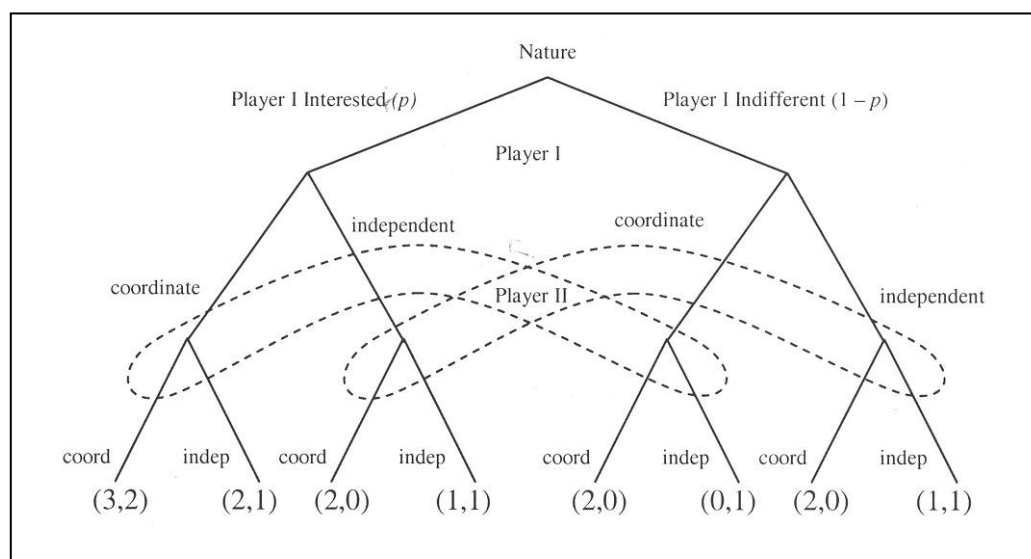
⁵⁶ Fudenberg and Tirole (1991) explain that “reputation”, as understood in terms of repeated games of complete information “...does not change the set of equilibria, and so this version of reputation does not have predictive power. Also, modelling reputations as complete-information strategies cannot capture the idea that a player's reputation corresponds to something that his opponents have learned about him” (page 367, footnote 1).

⁵⁷ These payoffs are ordinally arranged. It would be very simple to replace the numbers with something like:

	Coordinate	Independent		Coordinate	Independent
Coordinate	High, Medium	Medium, Low	Coordinate	Medium, 0	0, Low
Independent	Medium, 0	Low, Low	Independent	Medium, 0	Low, Low
Type A: Player I "Interested"			Type B: Player I "Indifferent"		

“Indifferent” Player I would choose not to signal his true type by playing *Independent*, as he is better off mimicking play by the “Interested” player. Therefore, for $p > 0.5$ there is a pooling equilibrium in *Coordinate*. With the “Indifferent” type willing to mimick the “Interested” one, there is no separating PBE of this game, while it can be proved that there is no pooling equilibrium in *Independent* either (the “Interested” type would deviate).

Figure 17
REPUTATION GAME



Therefore, if the game is repeated an infinite number of times, and there is no discounting of the future, (Coordinate, Coordinate) is an equilibrium in every period. In particular, the “Indifferent” type mimics the play of the “Interested” type, because if he doesn’t Player II will learn that he is really “Indifferent” and respond playing *Independent* forever. Therefore, a certain Player I who has a reputation for being “Interested” will want to preserve that reputation, even if it is “Indifferent”, just to prevent being identified as such by the other player.

This game, of course, can be made more complex by adding uncertainty about the type of all players, as shown by Milgrom and Roberts (1982). The key issue in that game is also that the existence of incomplete information about other players’ types might lead to reputation-building by players, so as to try to influence the outcome in a way that is favourable to them.

5. Equilibrium selection

Research on equilibrium selection tries to address the crucial question of: “What outcome is more likely to be observed empirically?”. In trying to answer that question, the economic profession has spawned a large number of papers in the literature about theoretical criteria and experimental evidence surrounding the actual play of coordination games. In this section, we first look at the issue equilibrium selection in static games and then in dynamic ones.

5.1 Focalness and risk dominance

A part of the literature, following original work by Schelling (1960) and picked up by several authors, has claimed that play in a game like Stag Hunt would result in the Pareto-superior equilibrium being played, due to the **focalness** of “payoff dominance” as a selecting device in the presence of multiple equilibria. The idea is that, because of its characteristics, a certain Nash equilibrium is focal and is more likely to be played than others. In particular, cultural, historical and

other reasons make that particular equilibrium “salient” in some sense. As pointed out by Straub (1995), an equilibrium is “payoff dominant” if there is no other equilibrium that gives larger payoffs to any of the players.

In the Stag Hunt example we presented in section III.1, the focalness of payoff dominance argument would suggest that the officials of each country reason that the others also want to achieve the Pareto-superior equilibrium and they will choose the action “*Invest*”. Focalness, unlike other equilibrium selection mechanisms we will review, might not be very realistic in an MPC framework. This is because of the multiplicity of possible actions and equilibria in the sorts of games that could be played by countries. In a complex game, and especially in the presence of imperfect information, it is difficult to believe that a certain outcome would be a focal point by itself (e.g., because it is “salient”). Farrell and Rabin (1996) also question the real world relevance of “tacit coordination” as an equilibrium-selection tool in general coordination games.

Figure 18
STAG HUNT NUMERICAL EXAMPLE

	Don't Invest	Invest
Don't Invest	0 , 0	3, -2
Invest	- 2 , 3	4, 4

Stag Hunt Numeric Example

Another fact to be noted is that playing the strategy *Invest* in our Stag Hunt example is more risky for each country than *Don't Invest*: with the latter, each player ensures himself a payoff of 0 no matter what the other player does. In the example of Figure 12, if each player believes that the other one will play *Don't Invest* with subjective probability greater than one third, both players will reach the Pareto-inferior Nash equilibrium. The concept behind the different relative riskiness of each strategy has been called “**risk dominance**” (Harsanyi and Selten, 1988; Cooper, 1999; Carlsson and Van Damme, 1993), and that criterion would suggest that the Pareto-inferior equilibrium (*Don't Invest*, *Don't Invest*) will be reached in the game. As shown by the experimental work by Straub (1995) with individuals, since the equilibrium (*Don't Invest*, *Don't Invest*) is associated with the largest product of deviation losses (whose value is 4, in our example, compared with the losses of 1 in the case of (*Invest*, *Invest*)), the strategy *Don't Invest* is risk dominant. The set of beliefs that justify playing *Don't Invest* is larger, making it less risky to play the Nash equilibrium. Camerer (2003) surveys the experimental evidence in a number of papers (e.g. Van Huyk et al, 1990), indicating that the Pareto-dominated equilibrium is indeed played most of the time in experimental Stag Hunt games.

The issue of equilibrium selection in one-shot coordination games is also closely related to the question about whether players can learn to play a Nash Equilibrium when playing a game more than once. As there is an extensive game theoretic literature about learning, it is not possible to provide a representative survey in this paper,⁵⁸ but the experiments conducted by Straub (1995) indicate that players do not seem to use only (instantaneous) deduction to reach a Nash Equilibrium, but follow a process over time that eventually leads to such a result. The exact nature of the process, the factors influencing the speed of convergence, etc., are all important subjects in current game-theoretic research.

⁵⁸ As an example of the interesting issues analysed by that literature, see Milgrom and Roberts (1991).

5.2 Forward induction

In dynamic games, the modeller can sometimes use other equilibrium selection tools. It is possible to modify the Stag Hunt game to offer one of the players the possibility of deciding between an outside option and playing the stag hunt game. This additional stage (the outside option) transforms the Stag Hunt game into a dynamic game. Following the “**forward induction**” concept proposed by Kohlberg and Mertens (1986), suppose that this outside option provides the player with a certain payoff which is higher than the payoff of the Pareto-dominated equilibrium in the game (namely, (*Don't Invest*, *Don't Invest*)). Then, if the player moving first chooses to ignore the outside option and play the game instead, the other player would believe that the strategy played by the first player in the simultaneous Stag Hunt game will be *Invest*, in order to achieve a higher payoff. Thereby, both players would play *Invest* and reach the Pareto superior equilibrium.

Forward induction, as pointed out by Myerson (1991) involves players behaving in a certain subgame in a way that is influenced by options faced earlier in the game. According to Camerer (2003), experimental evidence indicates that in repeated Battle of the Sexes (BOS) games the existence of an outside option for one of the players seems to facilitate coordination on the Nash equilibrium favouring that player. Since some evidence has shown an increase in coordination even when the available outside option provides a payoff to the player with the choice that is lower than the worst of the BOS Nash equilibria, Camerer (2003) indicates that such a result would only partly be explained by forward induction arguments. Forward induction, however, might be a difficult tool to work with in practical applications⁵⁹.

5.3 “Cheap Talk”

So far, we have not considered the possibility that players can communicate with each other in an effort to coordinate on a specific equilibrium⁶⁰. The player's capacity to costlessly send non-binding messages that do not directly affect payoffs is known as “**cheap talk**” (Farrell and Rabin (1996), Cooper (1999)). Cheap talk could allow players to coordinate on a specific equilibrium in a pure coordination game such as the one-shot Battle of the Sexes, where none of the pure-strategy equilibria is risk-dominant. However, in a Stag Hunt type of game, the presence of a risk dominant equilibrium (*Don't Invest*, *Don't Invest*) makes the announcement by players of their intention to play the *Invest* strategy less credible. Experimental evidence surveyed by Camerer (2003) about which of these equilibria are played in the presence of cheap talk indicates that one-way communication helped significantly to coordinate in a repeated BOS game, but two-way communication worked less well, due to the asymmetric nature of the payoffs in both BOS Nash equilibria.

In the academic discussion about the “virtues” of cheap talk, the key aspect is often whether the messages sent by the players are credible or not. Following Farrell and Rabin (1996), a message is **self-committing** when, if it is believed, the sender of the message is interested in doing what he said he would do. For example, in the Stag Hunt game in Figure 12, the action *Invest* is **self-committing** for both players: if country *j* believes the announcement by country *i* that he will *Invest*, the latter has an incentive to *Invest*. However, as pointed out by Baliga and Morris (2002)⁶¹, *coordinate* is not **self-signalling** in that game, in the sense that each player would want the other to believe that he is going to play *Invest*, even if he is not. This occurs because when country *i* chooses *Invest*, there is a positive externality on country *j*, independently of what country *i* does. A message is **self-signalling** if the sender only benefits from making the announcement when the message is true. This is certainly not the case in Figure 12, but is true in the game shown in Figure 13.

⁵⁹ See Myerson (1991) and the discussion about the relationship between forward induction and the iterative elimination of weakly dominated strategies.

⁶⁰ In the case of the BOS game, neither of the two pure-strategy equilibria is Pareto superior to the other, but any of the two is preferred to a non-equilibrium situation.

⁶¹ The concept of self-signalling is due to Robert Aumann.

Therefore, the credibility of a message is likely to be higher if it is both self-signalling and self-committing and in such circumstances the capacity of players of coordinating on a specific Pareto-efficient outcome by sending non-binding communications would also be higher.

Figure 19

A NUMERICAL EXAMPLE OF A SELF-SIGNALING & SELF-COMMITTING GAME

	Don't Invest	Invest
Don't Invest	0 , 0	- 1 , - 2
Invest	- 2 , - 1	4 , 4

A numeric example of a self-signalling & self-committing game

Cheap talk can be of particular interest in a game where the payoffs in the multiple Nash equilibria are asymmetric, as in the Battle of the Sexes game. Farrell (1987) analyses a BOS-type game where two firms have to decide whether to enter a certain market or not, knowing that if both enter, they will end up losing money. The author claims that, in the absence of any coordination mechanism, identical firms would play the same mixed-strategy equilibrium, randomising between entering and staying out. Farrell analyses what happens if players can make cheap talk announcements about their intentions regarding entry before having to decide. By assuming that if both firms make different announcements, they will actually carry them out (i.e. the Nash equilibrium with asymmetric strategies becomes focal), but if they make the same announcement they play the mixed strategy Nash equilibrium, the author proves that the probability of coordination failure falls with cheap talk. In particular, in his version of the BOS with perfect information, the longer the players talk, the more likely it is that they will reach one of the two Nash equilibria where each player plays a different action. However, even though communication helps, the fact that the payoffs to each player are different in both asymmetric equilibria (one obtains a higher payoff than the other) places a ceiling on how much cheap talk can help coordination: the more asymmetric the payoffs, the higher the likelihood of a coordination failure in the symmetric equilibrium of the extended BOS game that includes cheap talk.

Introducing cheap talk into a one-shot coordination game with incomplete information transforms it into a dynamic game. Baliga and Morris (2002) show that certain types of two player games with incomplete information and self-signalling payoffs can have an equilibrium with communication where each player reveals his true type.

IV. The role of dialogue in Latin America: self-interested coordination in the presence of multiple equilibria

Using game theoretic tools to model policy interaction has the advantage of allowing the analyst to think about:

- Why countries can be stuck in a low-payoff equilibrium when playing a game with multiple equilibria.
- How policy-makers can coordinate on a Pareto superior equilibrium in the presence of multiple equilibria (coordination games)

Until now, we have discussed a variety of different game structures that countries trying to coordinate could be playing, and which might result in a low equilibrium payoff being reached. We have also discussed equilibrium selection criteria, that is, what tools policymakers have available to coordinate on a Pareto-superior equilibrium. In this section, we will argue that macroeconomic dialogue among policy-makers can work towards the mentioned objective in two ways. First, by introducing a “cheap talk mechanism” capable of helping countries to coordinate their self-interested (i.e. non-cooperative) actions when playing a game. Second, by helping policymakers to learn from interacting with others and contributing to the establishment of a reputation for “collaborative” behaviour. Both aim at achieving the same objective: reaching a Pareto-superior outcome to the non-coordination outcome.

Over the years, many authors (e.g. Currie et. Al. (1989))⁶² have informally advocated the advantages of macroeconomic dialogue to assist countries to coordinate policies. In the case of Latin America, a recent example is Ghymers (2001, 2005), who describes the European coordination experience and advocates for macroeconomic dialogue between policymakers in order to coordinate macroeconomic policies within Latin America's sub-regional integration agreements, as implemented in the Macroeconomic Dialogue Network (REDIMA) Project⁶³. Along these lines, Heymann (2001) has proposed that policy interaction in MERCOSUR can be expected to follow a sequence that started with macroeconomic dialogue⁶⁴. Crockett (1989), has also suggested that international institutions have a central role in proposing consultation procedures and policy guidelines to national authorities⁶⁵. As proposed by previous work on the subject (e.g. Escaith, 2004; Ghymers, 2005), game theoretic models can provide a better understanding of the value of macroeconomic dialogue as a MPC tool and that this important contribution has often been neglected in the literature.

1. Macroeconomic dialogue as “Cheap Talk”

We mentioned in the previous section that **credible** “cheap talk” messages can aid players to reduce the probability of *ex post* coordination failure. In the context of Latin American policymaking, there is uncertainty about the incentives and constraints (e.g. political) faced by policymakers from different countries when setting policy. In such a setting, an open exchange of information and messages can help policymakers to credibly reveal their intended future behaviour to others. The empirical evidence gathered in an experimental setting (Camerer, 2003) indicates that communication can help players to achieve coordination.

The role of cheap talk is particularly important in the presence of incomplete information about the payoffs, possible actions, etc., of the authorities of other countries with which there is an expectation of future interaction, especially if interaction is expected to be frequent or even continuous. In the absence of direct conflict of interest (such as those of the Prisoner's Dilemma game), macroeconomic dialogue can help countries to dissipate uncertainty about each other's payoffs and beliefs. This has long been pointed out informally in the integration and policy coordination literature (e.g. Heymann 2001)⁶⁶. In terms of the models discussed, dialogue can convey information that updates policymakers' previous beliefs about more or less formalised models and heuristics used by policymakers when dealing with other partner countries. Therefore, even in the absence of joint policymaking (i.e. a fully cooperative solution to the externalities problem), interaction between policymakers can help to reach a Pareto-superior result.

⁶² About the advantages and need for dialogue, Currie et. Al (1989) writes: “It is sometimes suggested that the efficient exchange of information among the policymakers of different governments can be taken for granted, given the range and frequency of meetings of international policymakers. But it is important to distinguish different levels of information exchange. [...] Moreover, the range of relevant information includes that about potential policy responses to the policy actions of others (which in the academic literature are labelled, somewhat misleadingly, as “threats”), information about which will be exchanged only in rather special circumstances. Since knowledge of the potential policy reactions of others may be crucial in ensuring the attainment of efficient outcomes, it is a mistake to take for granted that information is efficiently exchanged. In general, national representations at international meetings show a marked reluctance to discuss hypothetical questions or to make conditional undertakings”, pp. 36 – 37.

⁶³ See footnote 8, Ghymers (2005) and www.eclac.org/redima

⁶⁴ Heymann (2004) proposes that: “It has often been recognized that the interaction of policies in MERCOSUR would likely follow a sequence: arrangements that require a strong degree of commitment by the participants may hardly be contemplated before having previously established a practice of working together through relatively lax schemes of exchange of information, consultation and joint discussion of economic projections and policy criteria” pp 23.

⁶⁵ “An international institution can constitute the forum for regular meetings of national policymakers, while its staff can provide a common data set as a basis for discussions. Moreover, when criteria are developed to facilitate a dialogue on policy consistency, there is an important role for disinterested analysis from a source that is clearly impartial”, Crockett (1989), page 349, second para.

⁶⁶ “[Relatively lax schemes of exchange of information, consultation and joint discussion of economic projections and policy criteria] would have a non-trivial content in making it easier for partners to predict the behavior of others and to consider opportunities for common action. In this respect, the existence of an expectation of repeated interaction would help in creating incentives for the participants to establish “mutual confidence”, and these incentives would be stronger the more countries value the maintenance of fluid relations with the others” Heymann (2001), pp. 23.

One of the advantages of macroeconomic dialogue as “cheap talk” is that it does not require complex contingent commitments or binding promises. Coordination occurs because it is strictly in the self-interest of each of the countries interacting, without the need for a supra-national entity that codifies and monitors behaviour and enforces rewards and punishments. This might be particularly useful in the case of Latin America, given the heterogeneity of the size, productive structure, fiscal situation, institutional development, credibility of the monetary authorities, and other differences among partner countries. It is precisely the complexity of designing cooperative, binding agreements in the presence of such heterogeneity that makes dialogue such an attractive coordinating mechanism due to its simplicity. This does not mean, however, that designing the framework where dialogue takes place is a trivial issue. It is not, due to the different levels of cheap talk that can be used. For example, low level exchanges of information might do a large percentage of the coordination work in some cases, whereas in others face-to-face personal contact between senior policymakers might be necessary.

2. Macroeconomic dialogue as a tool for learning and reputation-building

A large part of the academic literature assumes that rational players will play according to the Nash Equilibrium, due to their reliance on individualistic calculations, and it is also assumed that they will use all the available information about each player’s payoffs and beliefs. Because of the heavy burden imposed by such an assumption on the “common knowledge” character of all relevant information and the “rationality” of players, some quarters remain sceptical about the usefulness of game theory as an analytical tool to assist policymaking. Without delving into the complex issues of bounded rationality⁶⁷, some authors (e.g., Cox and Walker (2002); Van Huyck et al. (1990), among others), argue that to get to a Nash Equilibrium it is important to have learning from repeated play⁶⁸. Even in the absence of incomplete information, learning how other players are likely to play and whether play will eventually converge on a Nash Equilibrium is particularly important in coordination games where there are multiple equilibria.

Dialogue among policymakers can therefore also help to increase the possibility of achieving successful coordination⁶⁹, merely by “learning how to play”. Fostering technical exchanges and joint policy discussions among policymakers in related fields, even if they do not achieve (or aim to achieve) joint policy making, could facilitate the capacity of one country’s policymakers to understand the way their peers in other partner countries think and behave when setting macroeconomic policy in the presence of spillovers and strategic complementarity or substitutability. This role of dialogue as a learning tool for MPC has previously been put forward by Ghymers (1999⁷⁰, 2001, 2005), discussing some of the specific opportunities in Latin America⁷¹.

Macroeconomic dialogue can also help countries to coordinate policies by helping them to build a reputation for “collaborative” behaviour. When discussing games of incomplete information, we examined a game where policymakers faced uncertainty about the “type” of their counterparts, where “type” stood for how “interested” (or capable of pursuing) the authorities of other countries were in coordinating policies. In such a game, a policymaker’s “type” might indicate not only his willingness to engage in coordination, but also the capacity to do so, as indicated by the political,

⁶⁷ For the reader interested in the subject, see Ariel Rubinstein’s book “Modelling Bounded Rationality”, (Cambridge, MA: MIT Press 1999).

⁶⁸ We are not, however, talking about *repeated games* and the “Folk Theorem” as discussed above.

⁶⁹ This is distinct from the role of dialogue as “cheap talk” (coordination mechanism) described in the previous section.

⁷⁰ Ghymers, C. (1999), “The Macroeconomic Policy Coordination in the Euro-area: Origins, Development and Present Challenge, with some Possible Conclusions for Latin America”, XI ECLAC Regional Seminar on Fiscal Policy, Brasilia, January 1999.

⁷¹ “One important aspect of European cooperation on economic policies is its “learning by doing” component, essentially based on the interaction of two principles: the exchange of best practices among parties (not only among ministers, but, especially, among national experts), and market pressures that permanently test and question the credibility of the authorities and their policies”, Ghymers (2005), pp. 65-66.

economic and social constraints faced by those authorities. These constraints can be thought of as dynamic in nature (i.e. they change over time), while the complexities of the political process often make it impossible for other countries' policymakers to understand the true capacity of a country's authorities to pursue different policies at different moments. This reinforces the argument in favour of policymakers' types being private information. In the case of some countries in Latin America, where political conditions have changed rapidly at different moments of time, this general argument acquires increased relevance. Even in the presence of a "State policy" that guides the integration effort of each country, differences of opinion within the group of officials can add to the uncertainty as to the real probability that a specific country will choose to coordinate its policies or simply act independently. For that reason, reducing the amount of uncertainty about the concrete preferences and capabilities of policymakers can encourage the adoption of the strategies leading to a Pareto-superior outcome with coordination.

Finally, macroeconomic dialogue can also help to lay the groundwork for the joint setting of national macroeconomic policies in the future. This is because a protracted period of institution-building and national policy improvements helps to foster the creation of an environment of mutual trust among high-level officials in the region and generates the necessary conditions for the future implementation of policy cooperation with binding, supranational commitments (see Ghymers, 2005). This cooperative offshoot is one of the positive "side effects" of self-interested reputation building. Establishing coordination on a non-cooperative basis, however, does not require profound commitments on the part of participating countries towards cooperative solutions⁷². The only necessary condition is the acknowledgement of the existence of spillovers and strategic complementarities among partner countries, and the willingness to work creatively to find a solution that represents a Pareto improvement for all while satisfying each country's participation and incentive constraints.

⁷² It also discourages the setting of lax binding targets for regional policy setting, that can result when countries have little capacity or willingness to set tight (i.e. difficult or costly to meet) binding targets for macroeconomic policy.

V. Conclusion

The real world presents a series of challenges to the analyst who tries to build models of Macroeconomic Policy Coordination (MPC) among Latin American countries. The usage of game theoretic tools for this purpose constitutes a useful tool, as long as proper attention is paid to the sheer complexity of the issues at hand. Uncertainty, asymmetric information, dynamics, bounded rationality, behavioural consistency, coalition building within countries in the policymaking process, are all factors that contribute to the complexity of coordinating policies.

In this paper, we have discussed how some of this complexity can be incorporated in the analysis of policymakers, using standard non-cooperative game theory. We have suggested that in the presence of multiple equilibria, there is an urgent need for policymakers of partner countries to devise ways of avoiding coordination failure in their interactions. In particular, we claimed that macroeconomic dialogue can be useful to countries by: assisting them to coordinate on a Pareto-superior Nash Equilibrium (if this exists), thereby solving the multiple equilibria problem; by fostering the “learning” process about how to converge to a Pareto-efficient Nash Equilibrium; and by helping countries to build “reputational capital” about their willingness (or capacity) to carry out MPC with their partners.

After discussing static games where players have perfect information, we reviewed games of incomplete information, either static or dynamic, where players have beliefs about the “types” of opponents they are facing.

In more complex dynamic games, players update their beliefs by watching the other players' moves, and therefore the equilibrium sequences of beliefs and strategies of play cannot be separated. This explains why players might want to build a "reputation" for being of a certain type (e.g. *Interested* in coordinating, in our example): the aim is to influence other countries into playing a coordinating strategy that is universally advantageous⁷³.

At this point, it is worth indicating some of the important limitations related to the use of game theory for policymaking. Prominent among them is that game theoretic models normally assume that information about the "state of the world" is common knowledge to all players and that players have the same prior beliefs about the private information other players might have. In the case of macroeconomic policy setting in the presence of spillovers, this involves knowledge of things such as the form and strength of the interactions among countries, the economic models other countries use to carry out policy (something essential in the *ex ante* assessment of other players' reaction functions), etc. These assumptions are hardly innocuous. For example, in the case of dynamic games of imperfect information, if there are no common priors over private information, observing the action of another player might be less informative. In such a case, behaviour of other players might not be attributed to having received private information, but to having acted based on the "wrong" priors (Fudenberg and Tirole, 1991). Moreover, the literature also shows that changes in the informational structure of a certain game can have a significant impact on the expected equilibria of that game⁷⁴. Despite all of this, academic economists and policymakers from diverse extractions consider that game theory continues to provide valuable insights into possible ways of tackling the complex issues surrounding MPC implementation in Latin America. For this reason, we believe this paper provides the theoretical foundations to understand the need and usefulness of regular macroeconomic dialogue amongst policy-makers in Latin America, as implemented in the REDIMA project.

Finally, in this paper we join other contributors to this literature by pointing out that self-interested coordination over time can help to set the foundations for supra-national monitoring and enforcing of binding commitments in the future. Jointly setting (non-binding) targets or guidelines at the sub-regional level for macroeconomic variables such as inflation, budget deficits, indebtedness, etc., constitute useful steps that have been taken by MERCOSUR, the Andean Community and Central American countries, in that they provide a common ground upon which to base future policy discussions between countries. The viability of a cooperative solution (in which there is joint policy-making plus the allocation of joint gains among the parties) will demand much more effort. In particular, the parallel increase in the benefits from cooperation to every party is a crucial requirement, and will involve the establishment of effective compensation mechanisms to make transfer payments from winners to the losers. For example, the deepening of trade links, the creation of common markets for goods, services and factors of production, vertical integration of value-added chains across regional borders, etc., all contribute to strengthening the economic links between countries, increasing the potency of spillovers and strategic complementarity/substitutability in national policymaking and thereby strengthening the incentives for coordination. The gradual deepening of those links will probably be, however, a long lasting process, given the significant differences in economic structure, political institutions, size, etc., among Latin American countries that we mentioned before. The experience of European countries in the construction of the European Union points in that direction.

⁷³ We are assuming here that there are multiple equilibria and that countries are trying to coordinate on a certain existing Pareto-superior Nash Equilibrium. An example of such a game is a repeated version of the Stag Hunt game with uncertainty about (at least one of) the player's type.

⁷⁴ We will, however, refrain from delving into the discussion about the implications of less-than-common-knowledge. Issues such as whether there is convergence towards common knowledge posterior beliefs are beyond the scope of this paper. See, for a good textbook discussion, Fudenberg and Tirole (1991), Chapter 14.

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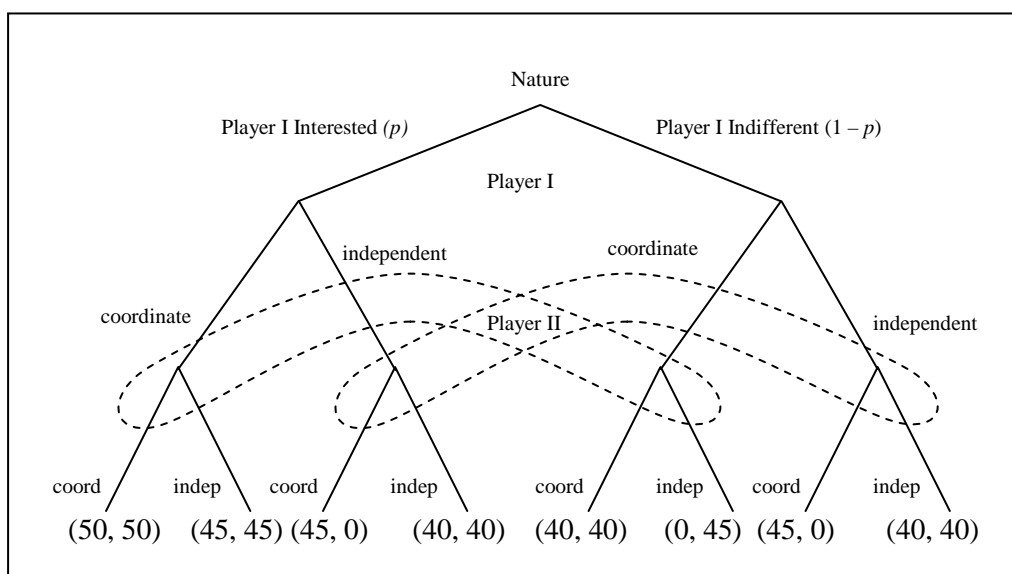
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Annex

Annex I

Here, we present two numerical examples of the signalling games in Figures 8 and 9 of Section III.4.I. The purpose of including these numerical examples is mainly to facilitate understanding of why the size of prior probability p determines responses of Player II to alternative Player I's observed action choices.

Game1
NUMERICAL VERSION OF FIGURE 8



The three possible outcomes are:

- **Pooling:** Both types of Player I choose *coordinate*

Since Player II will play *coordinate* iff $50\mu + 40(1 - \mu) > 45 \Rightarrow \mu > 0.5$, where μ is the posterior probability of Player I being *Interested* given that *coordinate* was observed, and we assume that the prior for $p = 0.25$, Player II answers with *independent* to the *coordinate* observed. Off the equilibrium path, Player II answers *independent* with *independent*.

The *Indifferent* type of Player I deviates to *independent*. The *Indifferent* type would never play *coordinate*, because it is a strongly dominated strategy (by *Independent*). So, there is no belief about off the equilibrium path moves that would prevent the *Indifferent* type of Player I from deviating.

Result: there's no pooling equilibrium in *coordinate*

- **Pooling:** Both types of Player I choose *independent*

Player II will answer with *independent* to the *independent* observed.

Indifferent type of Player I doesn't deviate from (*independent*, *independent*), but *Interested* type deviates, because for him it is dominant to play *coordinate*. There's no belief about off the equilibrium path actions that would prevent this type from deviating.

Result: there's no pooling equilibrium in *independent*

- **Separating:** *Interested* type of Player I plays *coordinate* and *Indifferent* type plays *independent*.

This means that $P(\text{coordinate}/\text{Interested})=1$ and $P(\text{independent}/\text{Indiff.})=1$

Since Player II will play coordinate iff $50\mu + 40(1 - \mu) > 45 \Rightarrow \mu > 0.5$, where μ is the posterior probability of Player I being Interested given that coordinate was observed, we can use Bayes rule to find

$$P(Inter./coord) = \frac{P(coord/Inter.) \times P(Inter.)}{P(coord/Inter.) \times P(Inter.) + P(coord/Indif.) \times P(Indif.)} = \frac{1 \times 0.25}{1 \times 0.25 + 0 \times 0.75} = 1$$

So, Player II will answer *coordinate* with *coordinate*.

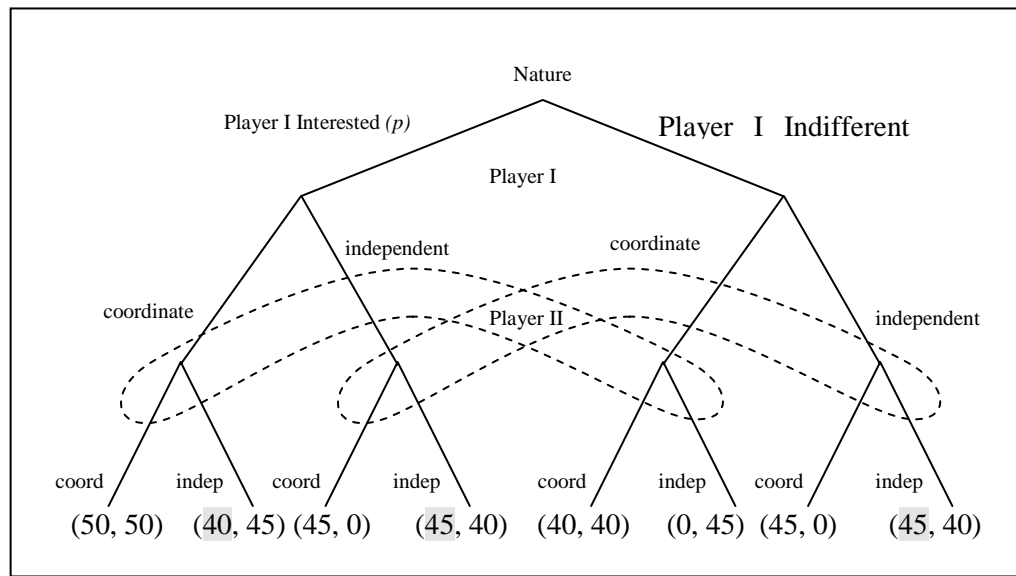
Player II's best response to *independent* is *independent*, regardless of Player I's type.

Neither type of Player I deviates from their chosen actions.

Result: there's a separating equilibrium where each type of Player I plays differently.

Now, we will look at a numerical example of the Game in Figure 9

Game 2
NUMERICAL VERSION OF FIGURE 9



The three possible outcomes are:

- **Pooling:** Both types of Player I choose *coordinate*

Since Player II will play coordinate iff $50\mu + 40(1 - \mu) > 45 \Rightarrow \mu > 0.5$, where μ is the posterior probability of Player I being *Interested* given that *coordinate* was observed, and we assume that the prior for $p = 0.25$, Player II answers with *independent* to the *coordinate* observed. Off the equilibrium path, Player II answers *independent* with *independent*.

The *Indifferent* type of Player I deviates to *independent*. The *Indifferent* type would never play *coordinate*, because it is a strongly dominated strategy (by *Independent*). So, there is no belief about off the equilibrium path moves that would prevent the *Indifferent* type of Player I from deviating.

Result: there's no pooling equilibrium in coordinate

- **Pooling:** Both types of Player I choose *independent*

Player II will answer with *independent* to the *independent* observed.

Indifferent type of Player I doesn't deviate from (*independent*, *independent*), and neither does the *Interested* type. We assume that if coordinate were to be played by Player I, Player II would answer with independent, because of the priors.

Result: there's a pooling equilibrium in *independent* where both types of Player I choose the same action

Note: The mentioned off-the-equilibrium-path behaviour (and belief) is suspect, though. If Player II were to observe coordinate, he knows that (unless by mistake) the Indifferent type of Player I would not play that strategy. Also, only the Interested type would benefit if it could convince Player II that he is Interested. Therefore, the probability that coordinate was played by the Interested type is high. Also, if coordinate were to be played by mistake by the Indifferent type, the potential loss is only 5 (from 45 to 40) while the potential gain is also 5 (from 45 to 50).

- **Separating:** *Interested* type of Player I plays *coordinate* and *Indifferent* type plays *independent*.

This means that $P(\text{coordinate}/\text{Interested})=1$ and $P(\text{independent}/\text{Indiff.})=1$

Since Player II will play coordinate iff $50\mu + 40(1 - \mu) > 45 \Rightarrow \mu > 0.5$, where μ is the posterior probability of Player I being Interested given that coordinate was observed, we can use Bayes rule to find

$$P(\text{Inter.}/\text{coord}) = \frac{P(\text{coord}/\text{Inter.}) \times P(\text{Inter.})}{P(\text{coord}/\text{Inter.}) \times P(\text{Inter.}) + P(\text{coord}/\text{Indif.}) \times P(\text{Indif.})} = \frac{1 \times 0.25}{1 \times 0.25 + 0 \times 0.75} = 1$$

So, Player II will answer *coordinate* with *coordinate*.

Player II's best response to *independent* is *independent*, regardless of Player I's type.

Neither type of Player I deviates from their chosen actions.

Result: there's a separating equilibrium where each type of Player I plays differently.

Annex II

Following Cooper and John (1988), assume that there are I players $I = 1, 2, \dots, I$, where agent i 's action is $m_i \in [0, M]$, where M is finite. The payoffs to player i are $\sigma(m_i, m_{-i}, \theta_i)$, where m_{-i} is a vector of actions chosen by all the other players, while θ_i is a parameter. We assume that each player's payoff function is continuously differentiable, that $\frac{\partial^2 \sigma()}{\partial m_i^2} < 0$, and that $\frac{\partial^2 \sigma()}{\partial m_i \partial \theta_i} > 0$

We indicate by $V(m_i, \bar{m})$ the **payoff** to player i of action m_i when all the other players play action \bar{m} , while $m_i^*(\bar{m})$ is the **optimal response** of player i when all other players play action \bar{m} .

In a Symmetric Nash Equilibrium (SNE), if all other players choose m , the remaining player will also choose e (i.e., $m_i^*(\bar{m}) = m$). In that case, the SNE of the game can be defined as

$S = \{m \in [0, M] / V_1(m, m) = 0\}$. V_1 is the partial derivative of the payoff function of player i with respect to his own action m_i . To make sure that the solution is interior and not a corner one, the authors assume that $\lim_{m \rightarrow 0} V_1(m, m) > 0$ and that $\lim_{m \rightarrow M} V_1(m, m) < 0$. This ensures the existence of a certain $m \in S$.

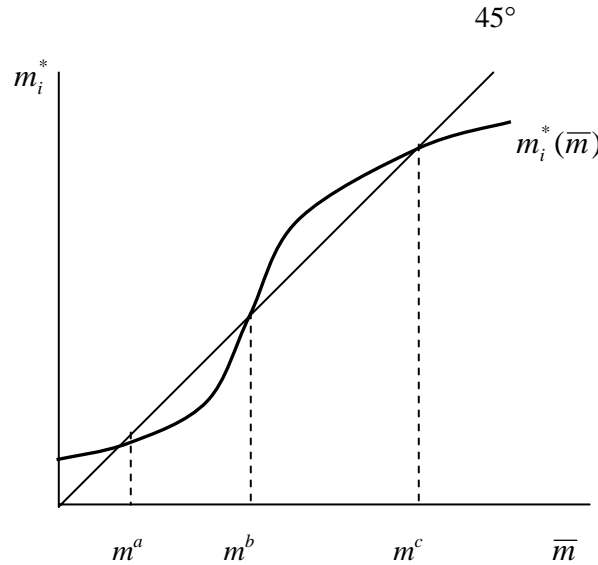
In this context, we can see that

If $V_2(m_i, \bar{m}) > 0$, the game has positive spillovers

If $V_2(m_i, \bar{m}) < 0$, the game has negative spillovers

If $V_{12}(m_i, \bar{m}) > 0$, the game presents strategic complementarity

If $V_{12}(m_i, \bar{m}) < 0$, the game presents strategic substitutability



Source: cooper and John's (1988) strategic complementarity diagram

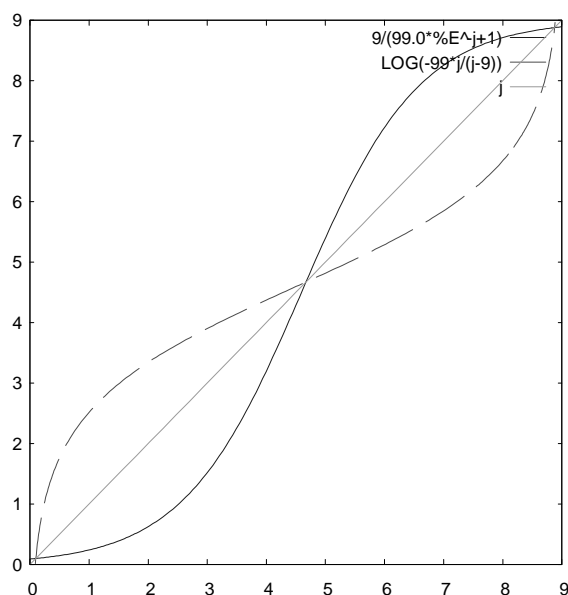
In the figure above, we see player i 's reaction function when all the other agents choose the same action. As Cooper and John (1988) explain, multiple intersections of the curve that this function allows us to draw are possible only if the slope of the curve is positive for some value of \bar{m} .

The slope of the function is $\rho = -\frac{V_{12}}{V_{11}}$. Since, by assumption, $V_{11} < 0$, $\rho > 0$ if and only if $V_{12} > 0$, that is, if the game exhibits strategic complementarities. Therefore, the existence of strategic complementarities is a necessary condition for the existence of multiple equilibria. A sufficient condition for the existence of multiple equilibria is $\rho > 1$.

A reaction function can produce results such as these (and in the case of two countries, as we saw in Figure 1 in Section II.I) when the (discrete) functional form of the reaction function is for

example, $m_i * (\bar{m}_j) = \frac{a}{(1 + bq^{\bar{m}_j})}$. For a numerical example, assuming that $a=9$, $b=99$ and $q=\exp(-1)$,

we find the curves in the next figure (computed using the software *MAXIMA*), where points a and c are close to 0 and 9 respectively, while unstable equilibrium point b takes a value around 4.7.





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